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CONTENTS.

An Early Issue. THE present issue of THE ELECTRICAL WORLD goes to press on Friday, Aug. 18, instead of three days later, as usual, in order that it may reach those in attendance at the International Electrical Congress previous to the opening of its sessions. The guide to the electrical features of the World's Fair, which we print in this issue, will be found of value, not only for use on the grounds, but also as a means to decide upon tours of inspection before visiting the Exhibition. Through it a programme may be intelligently laid down, and with the aid of the plans and elaborate index that accompany the guide, any exhibit or other point of interest can readily be found, thus enabling a double saving of time to be made.

Economy of Ventilating Fans. IN a paper recently read in England on the economy of ventilating fans low speeds are strongly advocated. While, as the author states, it is a waste of energy to move the air with a greater velocity than necessary, it does not follow that fans running at low speeds will give the best economy. Experiments have shown that the efficiency of fans is small at low speeds and increases gradually until a certain speed is reached that depends upon the design. In some elaborate tests made about twelve years ago in England with a large number of agricultural fans it was found that the efficiency became as low as eight or ten per cent. at moderately low speeds and increased to forty or fifty per cent. at high speeds. This efficiency is the ratio between the energy imparted to the air usefully and that supplied to the fan. If there was no object in attaining a high velocity of the column of air the total efficiency, of course, would have been found less at the higher velocity, but, on the other hand, the low efficiency of the fan as a machine at low speeds would not necessarily make the lower velocity the most efficient in total effect. Where two efficiencies vary oppositely, as in this case, there is always a point at which the total efficiency is a maximum. Owing besides to the wide variation of efficiency of fans of different dimensions, it is not safe to accept any theory in regard to the best speed of a given fan, which should be directly determined by experiment.

A Short-Sighted Policy. ONE of the first criticisms that our foreign visitors have to offer of the electrical features of the Fair is that there is so seldom any one in attendance on exhibits who can intelligently explain the apparatus in charge. It is not enough that a popular explanation be given; the technical man and the student want more. It has been a matter of surprise, even to those of us who are more accustomed to these things, to find fine exhibits, from which much could be learned if they were intelligently explained, placed in the hands of a lineman or dynamo tender who knows no more of the theory of his machine than the backwoods doctor does of the profession he practices. But this is not the worst. Not only are there exhibits of prominence in the electrical department in charge of men who can give no intelligent explanation of them, but there are firms making such exhibits who will not permit the visitors to acquire, if they can prevent it, such information for themselves. This is not as it should be, and has been the cause of no little unfavorable comment, especially among our visitors from abroad. The accusation has been made that Americans have stolen many of their best electrical devices, and this accusation has been made, not behind our backs, but openly and above board. That there has been some piracy is doubtless quite true, both on this side the Atlantic and on the other, but this disinclination on the part of many of our American exhibitors to permit investigation of the apparatus has doubtless caused suspicion often to rest where it ought not to be. If a person justly entitled to the device he is using publicly exhibits the same, it is shortsighted policy to withhold information in regard to it. There is still another shortsighted policy pursued by another class of exhibitors, to which attention was called only a few weeks ago. This class has avoided placing ignorant men in charge by having no one there at all. There are perhaps a dozen exhibits of merit in the Electricity Building where one will look in vain for an attendant of any kind, and, more than this, there is no literature at hand to explain the exhibit, and often even the labels are so small or ill-written as to be entirely illegible, or are in cases wanting altogether. It seems strange that a concern will go to the expense of a handsome exhibit and then willfully wash its hands of any benefits to be derived by its proper presentation to the public. We offer the suggestion for the benefit of these exhibitors that during the week of the Congress at least they have attendants in charge of their exhibits who can intelligibly answer intelligent questions.

What Is Electricity? ALTHOUGH we may never know what electricity really is any more than we now know what is life or the force of gravity, might we not at the present Electrical Congress plant a milestone in the progress of science by stating what we, at the present time, think it is? While no decree of these savants would compel an acceptation of their conclusions in regard to a subject of which the wisest will confess himself ignorant, still a formulation of the ideas now held by the advanced thinkers on the subject would go far toward lifting us to a new plane whence advancement might be easier. If in addition to promulgating an opinion that most nearly coincides with the ideas of the majority, the reasons for upholding that opinion and rejecting others were to be given, we think a distinct advance would have been made, and that it would throw some light upon the question as to where we stand to-day. It would give us at least a datum point from which to work, and this really is the foundation of all science. We admit at once the difficulty of formulating an opinion that would be acceptable in all its features to those whose opinions are of value, but we suggest that a discussion of this subject by a committee of the whole, under heads that might be decided upon by a special committee appointed for this purpose, might prove one of the most interesting and, in the end, one of the most valuable features of the Congress. Never before has there been gathered upon American soil such a number of men whose names are synonymous with the advancement of the science as will assemble at Chicago during the coming week. May we not look for a discussion from them of this most interesting subject? We know now that electricity is a phenomenon of the ether. According to Lord Kelvin's theory, matter is also a phenomenon of the ether. We know energy only as it is associated with matter. May there not be a nearer relation between what we term matter and what we know as the electric current than we have been accustomed to admit? If so, what is that relation? According to Lord Kelvin's theory the atom is a vortex ring of ether. Physical investigation has indicated that a closed electric circuit creates in the surrounding ether a vortex whirl, and the attraction and repulsion of electric currents between each other are most intelligently explained by the mutual mechanical action of these whirls. Is an electric circuit an exaggerated atom? If both are vortex rings, do the phenomena attending them differ only on account of the difference in their dimensions, as do light and heat? There are of course many questions of a purely speculative nature that will arise, but there are also many that are more capable of practical demonstration from already acquired knowledge that may be answered with a considerable degree of confidence. Nor would a discussion of the purely speculative questions be profitless, and, besides, they have a charm of their own which makes their discussion pleasant.

The International Electrical Congress. WHETHER the Chamber of Delegates of the International Electrical Congress, about to convene at Chicago, will consider favorably more than one or two, if any, of the propositions that will be brought before it, seems, at the present moment, a matter of some doubt. The fact that the quadrant, adopted at the Paris Congress of 1889, has not been accepted by the electrical public at large, will, doubtless, cause extreme caution in its action, and this is as it should be. As relates to questions of units and nomenclature, there are two distinct elements to be considered, and if either one does not accept the decrees of an electrical congress, its labors are nullified. On the one hand are the savants, professors and other purists, and on the other the great body occupied with the practical side of electrical science. It is not difficult to see that in many cases their interests lie far apart, for the requirement of schools and the precise methods of pure science may prove burdensome when imposed upon those to whom they do not appeal in any sense. It follows, therefore, that it is well to examine all such questions from both points of view, and to bear in mind that a victory for a unit or system that will not be generally accepted is a defeat for the true ends of science, and tends to discredit the body responsible for the measure. As far as units are concerned, if they become necessary in the industrial branch of the science, they will be created, and in the more theoretical branches, accustomed to dealing with abstractions, practical units are a hindrance rather than an aid. On questions of notation and symbols, however, it seems that there should be substantial unanimity in regard to the advantage of a uniform system. Both the makers and readers of electrical literature here meet on a common ground, and with this community of interests there should be no difficulty in arriving at definite conclusions, whose general acceptance would follow almost as a matter of course. The Congress might still further add to its usefulness by taking informal action on matters that could not be acted upon officially. Owing to its authoritative character, an expression of of opinion, even if merely advisory, would have great weight, and, in many cases, might advance a desired end far enough for definite action at another congress. As an example to point, we may cite the case of the candle power of arc lamps expressed in terms of watts. A matter that will have to be settled sooner or later is the extent of the power of one congress to reverse the action of preceding ones. An electrical congress is now a feature of every international exposition, and thus they meet at more frequent intervals than is at all necessary, as far as concerns matters relating to electrical units. One consequence of this that they cannot always have a representative character in the highest sense, and there is danger of ill-advised measures being adopted, and the stability of the work of other Congresses being affected. The high character of the delegates to the Chicago Congress is such as to render any action it may see fit to take on this point and on other questions certain of the most respectful consideration.

The International Electrical Congress.

The Congress will be opened at 3 o'clock p. m. on Monday, Aug. 21, and the following order of business will be observed:

1. The Congress will be called to order by the chairman of the local committee, Dr. Elisha Gray. 2. Election of temporary chairman and secretary. 3. Appointment of a committee to nominate permanent officers. The officers will consist of a president, a vice-president for each nation sending delegates to the Chamber, and a secretary. 4. Report of this committee. 5. Short addresses by the president and by a few of the vice-presidents. 6. Announcements and adjournments.

At the close of this meeting the Chamber of Delegates will assemble for preliminary organization, which will proceed as follows: 1. The chamber will be called to order by one of the delegates representing the United States. 2. Election of a temporary secretary. 3. Appointment of a committee of five on credentials. 4. Fixing a time for regular sessions. Adjournment. At the next meeting of the chamber the committee on credentials will report, and a permanent organization will be completed.

DIVISION INTO SECTIONS.

The General Congress will be divided into three sections, as follows: A. The section of Pure Theory, including electric waves, theories of electrolysis, electric conduction, magnetism, etc. B. The section of Theory and Practice, including studies of dynamos, motors, storage batteries, measuring instruments, materials for standards, etc. C. The section of Pure Practice, including telegraphy and telephony, electric signaling, electric traction, transmission of power, systems of illumination, etc.

These sections will meet for organization and work at 10 a. m., Aug. 22. Their organization will consist of the election of a chairman, a vice-chairman, a secretary and a sectional committee of three in addition to the officers named above. Temporary presiding officers will be as follows: Section A, Prof. H. A. Rowland; Section B, Prof. Charles R. Cross; Section C, Prof. A. Graham Bell. Sections will meet at 10 o'clock a. m. on Tuesday, Wednesday, Thursday and Friday, continuing in session at will except on Friday, when they will finally adjourn as sections not later than 1 o'clock p. m. Each section will have authority to divide into sub-sections if it is thought to be desirable.

The following is a corrected list of delegates to the Congress:

England—W. H. Preece, F. R. S.; Prof. W. E. Ayrton, F. R. S.; Prof. S. P. Thompson, D. Sc., F. R. S.; Alex. Siemens, Major-General C. E. Webber.

France.—M. Mascart, M. Hospitalier, M. Violle, M. de la Touanne.

Germany.—Dr. H. von Helmholtz, Dr. Budde, Dr. Lummer, Prof. Voit, Privy Councilor Schraeder.

United States.—Prof. H. A. Rowland, Prof. T. C. Mendenhall, Dr. H. S. Carhart, Prof. Elihu Thomson, Prof. Edward L. Nichols.

Switzerland.—Dr. A. Palaz, M. Thury, Dr. Weber.

British North America.—Mr. A. Higman.

Italy.—Prof. Galileo Ferraris.

Mexico.—Senor Don A. M. Chavez.

China.—Mr. Peng Kuang-Yu, Mr. Teng Shen, Mr. Shon Yen.

Dr. von Helmholtz requests that the following gentlemen of the Physikalische-Technische Reichsanstalt, of Charlottenburg, be allowed to attend the meetings of the Chamber of Delegates, namely: Dr. Feussner, Dr. Kurlbaum, Dr. Lemon, Dr. Lindeck and Dr. Pringsheim.

In addition to the above the following unofficial announcement has been made in regard to Austria: "In response to the invitation extended to it to participate in the Electrical Congress to be held in Chicago the Electrotechnischer Verein of Vienna has appointed the following of its members delegates to represent it at the meetings: Nikola Tesla, A. Prosch, Inspector of Austrian State Railways; Ernst Egger, Dr. Johann Sahulka, constructor at the Imperial High School, Vienna; Fred W. Tischendoerfer and Joseph Wetzler."

Whether it is intended that five of the last-named gentlemen shall sit in the Chamber of Delegates or not is not at present known; this question, as well as the request of Dr. H. von Helmholtz in respect to his confreres, and the fact that China has appointed three delegates whereas only one was allowed, will have to be referred to the Committee on Credentials at the opening of the Congress.

The following is a complete list to date (Aug. 18) of papers to be read before the Congress, classified according to section:

Section A.—On a Determination of the Velocity of Propagation of Electrical Waves in Wires, by Prof. A. G. Webster.—Method in Scientific Nomenclature, by E. Hospitalier.—Explanation of the Ferranti Phenomenon, by Dr. J. Sahulka.—On the Analytical Treatment of Alternating Currents, by Prof. A. Macfarlane.—On Measuring the Power of Polyphase Currents, by A. Blondel.—Complex Quantities and Their Application in Electrical Engineering, by Chas. P. Steinmetz.—General Discussion of the Current Flow in Two Mutually Related Circuits Containing Capacity, by Drs. Bedell and Crehore.—Periodic Variation of the Candle Power of Alternating Arc Lights, by Prof. B. F. Thomas.

Section B.—Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper, by A. E. Kennelly.—Various Uses of the Electrostatic Voltmeter, by Dr. J. Sahulka.—The Action of Elihu Thomson's Transformer-Motor, by Dr. J. Sahulka.—Iron for Transformers, from the Magnetic point of View, by Prof. J. A. Ewing.—On a Method of Governing the Electric Motor for Chronograph Purposes, by Prof. A. G. Webster.—On the Construction of Cables for Subterranean High-Tension Circuits, by Dr. A. Palaz.—Transformer Diagrams Experimentally Determined, by Dr. F. Bedell.—London Electrical Engineering Laboratories, by Prof. A. Jamieson.—On the Sources and Effects of Harmonics in Alternating Circuits, by Prof. H. W. Rowland.—A Pair of Electrostatic Voltmeters, by Prof. H. S. Carhart.—On the Maximum Efficiency of an Arc Lamp with a Constant Number of Watts, by Prof. H. S. Carhart.—On Direct Current Dynamos of Very High Potential, by Prof. F. S. Crocker.—On an Improved Instrument for Measuring Magnetic Reluctance, by A. E. Kennelly.—Ocean Telephony, By Prof. Silvanus P. Thompson.—Signaling Through Space by Means of Electro-Magnetic Vibrations, by W. H. Preece.—Material for Standards of Resistance, and Their Construction, by Dr. Lindeck.—Variation of P. D. of the Electric Arc, with Current, Size of Carbons and Distance Apart, by A. Yerton.

Section C.—Rotary Mercurial Air Pumps, by Dr. Shulze-Berge.—A Hundred-Hour Electric Arc Light, by Prof. L. B. Marks.—The Conversion of Alternating Into Continuous Currents, by Dr. Pollak.—The Use of Accumulators in Central Stations, by Dr. Pollak.—Underground Electric Construction in the United States, by Prof. D. C. Jackson.—A New Incandescent Arc Light, by Prof. L. B. Marks.

Nikola Tesla will deliver a lecture on Friday evening, Aug. 25, in one of the halls on the World's Fair grounds.

Nomenclature, Symbols and Notation.

BY E. HOSPITALIER.

The interest taken by The Electrical World for some months in the questions relating to nomenclature, symbols and notations encourages me to present here, on the eve of the opening of the International Congress of Electricians, some observations suggested to me, by the various articles and discussions published on these questions since they were formulated in the provisional programme of the Committee of the American Institute of Electrical Engineers.

The divergence of views expressed by different authors seems to have their origin, to my mind, in the absolute lack of method which has presided at the formation of scientific language in general and of electrical language in particular. If the Congress of 1893 could put a little order and logic in the terminology, lay down the rules to follow in the creation of new quantities and units, of which the number increase each day with the needs of science and the industries, it would render the greatest of services to electricity.

The most important relates to the definition of physical quantities. A physical quantity cannot be, and ought not to be, defined except as a function of two or several other physical quantities, and without introducing units in the definition. This rule, too often disregarded, if strictly applied would suppress certain fantastic definitions, such as the following: *Power*, work per second; *Specific resistance*, resistance per cubic centimetre.

In reality, power is the quotient of work by time, and the unit of power is the quotient of the unit of work by the unit of time. The definition of specific resistance is still more absurd, for the definition as given above implies that specific resistance is a quotient of a resistance by a volume, and is therefore measured in ohms-centimetres-cubes, while, in reality, it is the product of a resistance into a length and is measured in ohm-centimetres.

As concerns the names of units, I should like to see regulated once for all the formation of compound names, and the adoption between the two of the hyphen when the two units which form the compound unit are a product, and the word *per* when they are the quotient of the first by the second. Thus, for example, the unit of velocity is *centimetre-per-second*, the quotient of the centimetre by the second; and the practical unit of electrical energy is the *ampere hour*, the product of the ampère and the hour. It is for this that I have always protested against the name of *bougie-metre* given to the unit of light, for this special unit is not the product of the bougie by the metre, as implied by the name.

As concerns more especially the names of electrical units, I believe it well to follow the rule already adopted by the preceding congresses, and which consists in giving the names of men who have honored the science to new units. It is for this reason that, notwithstanding the vote of the Congress of Electricians at Paris, in 1889, it seems to me necessary to replace the name of *quadrant*, given to the practical unit of the coefficient of self-induction, by another more appropriate, and I strongly favor the *Henry*, already sanctioned by use in America and England. I could give other reasons if I did not fear to be accused of fishing for American popularity.

As concerns symbols and abbreviations, I favor the decision of the Congress of Electricians at Frankfort, in 1891, making, however, some reservations on the rigorous application of the systematic use of Greek letters for coefficients or for physical constants. The symbols ought to be in italics and the abbreviations in romans. In order to augment the number of disposable letters, it is proposed to reserve the German text letters for all the magnetic quantities with the sole exception of the flux of force, now represented in many works by the Greek letter Φ. The Gothic letters sometimes employed in Germany present, to my mind, too great a complication, rendering reading and writing difficult.

As concerns the representation of physical quantities having the same dimensions by the same symbols, the observations published by Prof. A. Macfarland, in the July number of the "Transactions of the American Institute of Electrical Engineers," are perfectly just from the theoretical point of view and as relates to questions of higher analysis, but it should not be lost sight of that the matter at issue is to establish above all a simple and practical system of notations, of which the principal end is to enable engineers to understand the formulas published in the works of different countries without being obliged to make a special study of the notation adopted by each author.

When the true dimensions of physical quantities are all known, there will then be time to take up the question definitely and to make choice of symbols *ne varietur*; perfection being impossible of attainment in this world, it is better to have imperfect conventions rather than none at all.

The system proposed by Drs. Bedell and Crehore, and reproduced in The Electrical World of Aug. 12, 1893, (page 112), lacks entirely in method in the choice of symbols representing different physical quantities. They retain, for example, German text letters $\mathfrak{J}$, $\mathfrak{M}$, $\mathfrak{R}$, while they adopt full-faced letters, **B** and **H**, for the other magnetic quantities. On account of the time required in writing these latter characters with the pen or on the blackboard, I do not believe it advisable to adopt them, but to reserve, systematically and exclusively, German text letters for the magnetic quantities now created, and for those that will be added in the future. The employment of indices to represent constant, maxima and effective (square root of mean squares) values seems to me preferable to the complicated notation proposed by Drs. Bedell and Crehore, a notation that uselessly burdens the memory and introduces new typographical difficulties. We can write more simply, if, for example, it is a question of the strength of current

I for constant strength.
I_t for the strength at a given instant.
I_{max} for the maximum strength.
I_{eff} for the effective strength (square root of mean squares),

and so on. The choice of small letters for the value at a given instant may cause confusion. Thus, for example, if P is the symbol of power, the power at a given instant in the system of Drs Bedell and Crehore would be p, and thus be confounded with pressure p), or with any other physical quantity having the same dimensions.

I present these observations, which could be extended, not so much with a view of criticising the system proposed by Drs. Bedell and Crehore, as to show the pressing necessity of a rigorous method, as well in the definitions of physical quantities and their units as in the choice of the symbols destined to represent them with some chance of international adoption. The Congress which will soon begin its sessions will tell us in what measure an agreement can be arrived at, but whatever may be the fate reserved for my propositions I shall continue to uphold those that will not be welcomed, knowing by experience that several blows of a hammer are necessary to drive even the smallest nail.

Electromagnetic and Electrostatic Hysteresis.

BY CHAS. PROTEUS STEINMETZ.

Some years ago I noticed that the loss of energy by magnetic hysteresis can be expressed by the empirical formula: $H = \eta B^{1.6}$, where H is the loss of energy per complete cycle of magnetization, in ergs per cm.^{3}, B is the magnetic induction in loss of force per cm.^{2}, and η a "coefficient of hysteresis," which varies in soft iron from .002 to .005, averages .013 in gray cast iron, and varies in cast steel from .003 or even lower in very soft steel of very small percentage of carbon up to .028 and more in hard, highly carbonaceous cast steel, and reaches in hardened magnet steel as high as .08 and more.*

Later I observed that this law of magnetic hysteresis has the more general form: $H = \eta \left(\frac{B_1 - B_2}{2}\right)^{1.6}$, where B_1 and B_2 are the limits of magnetic induction, between which the cycle is completed. That means that the hysteretic loss depends upon the amplitude of the magnetic variation only; that is, upon the difference between the limiting values of the cycle, but not upon their absolute values.†

The same law has been found to apply to all other magnetic materials, as nickel, cobalt, tetroxide of iron, iron alloys, etc.†

This empirical law I verified in soft iron for the whole range from $B = 85$ up to $B = 19{,}300$, and found η constant: that is, the loss per cycle independent of the frequency.

*Transactions of American Institute of Electrical Engineers Jan. 19 and Sept. 27, 1892.

† Transactions American Institute of Electrical Engineers, Sept. 27, 1892.

for frequencies from 28 up to over 200 complete cycles per second.

For very high magnetizations, the law of 1.6 power cannot apply, if as B the total magnetic induction μ H = 4 π κ H + H is used, since in this case B infinitely increases with increasing M. M. F. H, while the loss of energy H appears to approach a finite limiting value. If, however, as B the "metallic magnetic induction" 4 π κ H, is used, which reaches a finite value of absolute magnetic saturation somewhere about 20,000, the law of 1.6 power seems to express the loss of energy up to the highest M. M. Fs.

For very low M. M. Fs., however, a point must be reached where this law ceases to exist by coming in contradiction with the law of conservation of energy†.

The potential energy per cycle of magnetization is: $W = 2\int_{-R}^{B} F\,dB$, where R is the remanent, B the maximum magnetic induction, and F the M. M. F. Hence, since for very low magnetizations B becomes proportional to F, ‡ $W \leqq 4\,BF = 4\,B^2\rho$, hence decreases proportionally to B^2, while $H = \eta B^{1.6}$ decreases proportionally only to $B^{1.6}$, and would therefore at a certain value of B (which in a sample of soft iron I found by calculation at about B = .2) become equal and larger than W, which is impossible.

The same consideration must apply to the electrostatic hysteresis also, if this follows the same law of 1.6 power.

For very slow cycles, however, especially with soft iron, under circumstances the hysteretic loss becomes indefinite, together with the magnetic induction, by the phenomenon of *magnetic creeping*.

If a magnetic cycle is gone through with a considerable speed, the value of magnetic induction B depends only and exclusively upon the instantaneous value of M. M. F. F, and upon the two limits of the cycle B_1 and B_2, as soon as a sufficient number of cycles are completed to make the condition stationary. Hence the magnetic induction B is a univalent function of the M. M. F. and the limiting values of induction.

If, however, the magnetic cycle takes place very slowly, an after effect appears, and the magnetic induction does not instantly after application of the M. M. F. assume its definite value, but "creeps" slowly upward, and becomes stationary only after seconds and even minutes. This effect is specially marked in soft iron on the part of the magnetic characteristic below the knee. The result hereof is that, compared with the higher frequency cycle, for very slow cycles all the values of magnetic induction are increased, and therefore the limiting values, B_1 and B_2, and the area of the hysteretic loop—that is, the loss of energy, H—are increased in the same proportion. This means that the hysteretic coefficient η is apparently decreased; that is, the loss of energy for a cycle between the same limits of magnetic induction is less, for a cycle between the same limits of M. M. F. is larger in a very slow cycle than it is in a high frequency cycle.

This phenomenon makes the application of the ballistic and magnetometer tests of hysteretic loss for the alternating current practice suspicious.

In electro-dynamometer tests, however, it is difficult to determine the maximum value of M. M. F., in consequence of the distortion of the current wave from sine shape, and correction has to be made for the self-induction of the movable or shunt coil of the instrument, which correction is very large in such circuits of low energy factor; and since the energy factor of the wattmeter circuit—that is, the ratio of the true watts to the apparent watts—varies with the magnetization, reaches a maximum for a certain medium magnetization, and then rapidly decreases, the wattmeter is variable, and the error therein consequently affects the shape of the curve of hysteretic loss.

The indicator card methods of determination of hysteretic loss necessarily suffer from the (greater or lower) mechanical inertia of the moving parts.

A phenomenon called "viscous magnetic hysteresis" that is, an increase of the hysteretic loss per cycle with increasing frequency—has been vainly looked for, but has not been found below 200 cycles, the highest frequency until now tested.

There exists, indeed, a phenomenon which, with a certain right, may be called "viscous hysteresis," in so far as it has its effect: the eddy currents or Foucault currents in the iron. They cause a loss of energy, which per cycle is proportional to the frequency N, to the square of the magnetic induction B, and the square of the thickness of the iron laminæ d. Hence it can be expressed, in ergs per cm³, by:

$$H^1 = \frac{1\,\pi^2}{6}\,c\,d^2\,N\,B^2\,10^{-9}$$

where c is the specific electric conductivity of the iron, which for soft sheet iron can be assumed approximately as 100,000 ohm-centimetres. This formula very closely agrees with practical experience.

Hence the loss of energy per cycle in laminated iron can be expressed by:

$$L = \eta\,B^{1.6} + \frac{1\,\pi^2}{6}\,c\,d^2\,N\,B^2\,10^{-9}$$

$$= .0033\,B^{1.6} + .145\,d^2\,N\,B^2\,10^{-4}$$

ergs per cm³.

For the electrostatic circuit until now very little has been done to investigate the law of the loss of energy by what we may call *electrostatic or dielectric hysteresis*.

A highly interesting investigation by Mr. R. Arno* of the energy loss in an ebonite cylinder in a rotating electrostatic field shows the loss of energy between the average field intensities of F = .95 and F = 3.83 electrostatic (C. G. S.) units as proportional to the 1.6th power of the field intensity, hence gives the same law for the electrostatic as for the electromagnetic hysteresis, which is highly interesting, since it gives this empirical law a more universal meaning, though it does not give an explanation of the unwieldy exponent 1.6. Probably this exponent is an approximation only, like the exponent 1.4 in the adiabatic compression of gases; if a deviation from 1.6 exists the probability is that the exact value is *slightly less than 1.6*.

Some time ago I made tests on electrostatic hysteresis at a frequency of 170 cycles per second, by measuring by means of the electro-dynamometer method the consumption of energy in a paraffined paper condenser.† These tests, covering the range from 88 to 340 volts, gave a very close proportionality of the loss of energy in the condenser with the square of the voltage; that is, with the square of the electrostatic field strength, though at the time of making these tests I expected a different law.

Later I repeated these tests with a method which is better suited to check the law, and which it may be of interest therefore to describe here.

Again an electro-dynamometer was used for measuring the loss of energy, while current strength and voltage were determined by two other electro-dynamometers.

If no energy were consumed in the wattmeter circuit, the current should be in quadrature with the E. M. F. Due to electrostatic hysteresis, the current leads by less than 90 degrees, by 90 degrees — α, only, where α may be called the "angle of hysteretic lag." The loss of energy is then: $H = c\,e \sin \alpha$.

If now $s = 2\,\pi$ N L is the ohmic inductance, r the resistance of the movable or shunt circuit, the angle of lag of this circuit is given by: $\tan \omega = \frac{r}{s}$, hence constant, and independent of the E. M. F.

The wattmeter deflection is: $W = c\,e \cos \omega \sin (\alpha - \omega)$.

Consequently, choosing inductance and resistance of the shunt circuit so as to make ω nearly equal to α, a small variation of the hysteretic angle α—that is, a small deviation of the loss from proportionality with the square of E. M. F.—causes a large percentual variation of $\alpha - \omega$, that is, of the wattmeter reading, so that this method is very sensitive for separating losses following the square law from losses following any other law.

For a variation of the E. M. F. in the range 1 ÷ 5 I found the angle $\alpha - \omega$ constant within the errors of observation.‡

A moment's thought will show that the same consideration applies also to the case of a wave different from sine shape.

These results, in combination with Mr. Arno's recent researches, seem to point to the existence of two different sources of energy loss in condensers, which probably may be *static* and *viscous dielectric hysteresis*, the latter being an analogon of the eddy currents in the magnetic circuit.

My tests were made with E. M. Fs. from 88 volts to 340 volts. Assuming the thickness of the dielectric in the condenser as .005 centimetre, the electrostatic gradient, or dielectric induction density, is 17,600 to 68,000 volt-centimetres, or 59 to 230 electrostatic units; hence, assuming for paraffined paper a dielectric constant 2, we get an electrostatic field intensity of 29.5 to 115 (C. G. S.) units, while Mr. Arno's tests cover the average field intensities .95 to 3.83; hence probably still less in the ebonite cylinder, due to its higher dielectric constant.

Hence the lowest field intensity in my tests was still 7.7 times higher than the highest intensity in Mr. Arno's tests, while the frequency 170 complete cycles was probably about four times as high as in Arno's tests.

Hence, if the viscous dielectric hysteresis varies with the square of frequency and of field intensity, similar to the eddy current loss in the magnetic circuit, while the static dielectric hysteresis follows the law of electromagnetic hysteresis, the former will be negligable at lower frequencies and low field intensities, while the latter may be entirely obscured by the effect of viscous hysteresis at high frequencies and intensities.

In both tests, however, due to the presence of air, which has a very large dielectric hysteresis, evidently a complex phenomenon has been observed, which makes a numerical calculation of the coefficient of dielectric hysteresis impossible. In my tests the lead of current was 85.4 degrees, hence the energy factor of the condenser cos 85.4 = .08, corresponding to an angle of hysteretic lag: α = 4.6 degrees.

Another very important question is answered by the existence of the phenomenon of dielectric hysteresis. Since during the cycle of electrization in the dielectric energy is consumed, the electrified dielectric must contain potential energy, that is, energy must be stored up in the dielectric, and in consequence hereof the dielectric is essential for the existence of the electric disturbance, and the disturbance travels with a finite speed in the dielectric.

* Ewing, "Magnetic Induction in Iron and Other Metals," chapter VII. Kennelly, Transactions American Institute of Electrical Engineers, Oct. 27, 1891.

† Transactions American Institute of Electrical Engineers, Sept. 27, 1892, Appendix II.

‡ Raleigh; see Ewing, "Magnetic Induction in Iron and Other Metals," p. 120.

* R. Arno, "La Lumière Electrique," July 15, 1892.

† "Electrotechnische Zeitschrift," 1892, Sept. 18, p. 227. "Electrical Engineer," New York, March 16, 1892.

‡ It may be remarked here, that the analogous method in the case of electromagnetic hysteresis is very conveniently applied for eliminating the eddy current loss, which causes an advance of phase of the current by a constant angle α, and therefore can be compensated by shunting a part of the additional wattmeter resistance by a condenser, which causes a lead of the shunt current by an angle $\omega = \alpha$, so that the wattmeter directly reads the true hysteresis.

Incandescent Lamp Tests.

The Electrical Jury of Award of the World's Fair has decided upon an elaborate system of tests for incandescent lamps which promises to produce some much-needed data. The scheme as finally adopted and announced is as follows:

The points to be examined are: (a) Initial candle power (mean horizontal). (b) Initial efficiency. (c) Life test. (d) Time at which blackening becomes appreciable and also, if time will permit, resistance, when cold, at various intervals (vacuum test). (e) Average efficiency through whole life of lamp.

Current Supply.—The Fort Wayne Electric Company has placed an engine and all dynamo machinery necessary at the disposal of the committee.

This machinery will have nothing to do except to supply current to the lamps under test—110-volt lamps will be supplied with direct current, and 50-volt lamps with alternating. Lamps will be placed on racks, on circuits of heavy copper rod, all lamps of a given voltage being on one circuit. Careful provision will be made to maintain voltage constant.

Standards.—The English sperm candle for candle power.

Electrical standards as agreed upon by the Sub-Committee on Instruments.

Instruments.—For candle power measurements, a Lummer-Brodhun photometer; length of bar 250 ohms; Methven screens using carbureted gas—gas passed through a sensitive gas pressure governor. Carbureter to be filled with gasoline distilled between 35 degrees and 50 degrees centigrade, from 30 degrees gasoline.

The electrical instruments used will be Weston instruments, which will be tested at the beginning of the test, and at intervals during its progress, by subcommittee No. 1 (on instruments, etc.).

Recording voltmeters (if such can be obtained) will be placed on the life test circuits.

Scheme of Test.—The photometer being properly mounted, the Methven screen will be tested by comparison with standard candles. This test being satisfactorily completed, two or more 32 candle power lamps, of proper voltage and carefully selected with reference to uniformity of radiation in a given direction, will be tested at standard voltage. One of these lamps, so measured, and thereafter designated as working standards, will be placed on the photometer. Each lamp entered for test will then be compared with the working standard, both being carefully adjusted to standard potential. The mean horizontal intensity of each lamp will be obtained, preferably by spinning, when under comparison with the working standard, which latter will be maintained at about 16 candle power. The candle power of each lamp in a marked position (azimuth) will also be determined at the same time, and its "position factor" derived. At the same time that the photometric work is done on each lamp, careful readings of potential and current, or of potential and watts, will be taken. It should have been stated earlier that a storage battery of proper size will be used to furnish current to all lamps when under photometric tests, and rheostats and switches in connection with the battery, so that the lamps may be run at the exact voltage intended.

After the initial measurements are made, the lamps, each tagged or otherwise marked with an individual number, will be placed on the rack. The rack or rack section being filled, switches will be closed, time noted, potential carefully adjusted, and maintained constant.

At intervals (as small as convenient in the earlier days of the life test) each lamp will be removed from the test rack, placed on photometer in its "marked position," and readings of candle power, voltage and current (or watts) taken.

Complete records of all things affecting the tests or results will be kept in proper blank books.

Results.—The data of the test will be completed and tabulated so as to show the following points:

(1) Mean horizontal candle power, and percentage of initial candle power, at each reading, throughout the test. (2) Efficiency (watts per candle power) at each reading. (3) Time of breaking of each lamp broken. Curves to express the above relations for the average result of each lot of lamps to be prepared. (4) Average cost of candle-power-hour of light produced by each make of lamp at intervals through its life, such cost to include price of lamp (assumed to be 45 cents per lamp for each make), and cost of current at some figure mutually agreed upon, or at different figures, as charged by central stations in operation.

Report.—A report upon the test giving a full account of all points concerning the methods and instruments used, details of machinery and circuits, all original readings, etc., will be formally made to the proper official of the Exposition, with the recommendation that it be printed at the earliest possible date. If prompt printing is not found possible, permission to give the report to the electrical press will be asked.

In answer to the question of lamp representatives present, it was ruled that lamp representatives would not be allowed to be present during or to take notes upon the tests or records of any other tests than their own.

A New Hot Wire Voltmeter.

BY A. S. KIMBALL.

For some time a modification of the hot wire voltmeter has been used in the laboratory of the Worcester Polytechnic Institute which seems to possess sufficient novelty to merit description.

It was devised several years ago for a special piece of work which needed a non-inductive instrument for alternating circuits of low potential.

The defects and limitations of the hot wire voltmeter are well understood, but convenience keeps it in use.

In the instrument under consideration certain errors belonging to the class are eliminated, others are diminished in amount, and others possibly are introduced. It is not in its present form suited to commercial work, but the simplicity of construction and its convenience commend it for laboratory work of a certain sort.

The description which follows is of an instrument now in use. Its dimensions were determined by the work for which it was designed and may be greatly varied.

Approximate dimensions are given on Fig. 1. Four No. 34 German silver wires, 1.1', 2.2', 3.3', 4.4', hang from the ends of adjusting springs placed at the corners of a square hole cut in the top of a tall wooden box. At their lower ends 1.1' and 4.4' are joined by a silk thread, which passes around a thin, loose pulley, P, on the axis A B; 2.2' and 3.3 are joined similarly by a thread on a second pulley, P'. The wires 1.1' and 3.3', 2.2' and 4.4', diagonally opposite each other, are in metallic connection at their lower ends, as shown in the figure. From the axis A B hangs a plate of metal, as shown, with an attached mirror, M. The lower end of the plate hangs in a dish of water to damp its vibrations. It is evident from the figure that if a current be passed through 1.1' and 3.3' that the elongation of these wires will allow the suspended systems to rotate clockhandwise as we look upon it from above, and in the opposite direction if the current is sent through 2.2' and 4.4'.

In fact the heavy plate has a double bifilar suspension, with oppositely directed couplers, and rotation is caused by varying the length of either pair of suspensions.

It is also obvious that if both pairs of suspending wires be elongated equally by the same or equal currents there will be no rotation if the wires are similar and the suspensions are symmetrical.

As in the ordinary bifilar balance, any desired degree of delicacy may be obtained by regulating the length of the wires, the diameter of the pulleys and the distance of the upper suspension on points from each other. Temperature errors are practically eliminated in this instrument, as one would predict from the arrangement of the suspension wires.

There are no pivots or delicate moving parts to get out of order. The pulleys do not turn on their axis in use. They only serve to secure equal tension on the wires in the first adjustment of the instrument.

The directing force is gravity, and the suspended plate may be made heavy enough to secure perfectly definite indications. Some of the uses to which this instrument may be put are obvious. It may be calibrated and used as a voltmeter, sending the current through one pair of suspension wires. It may be made so sensitive that by the use of shunts it may serve as an ammeter without excessive loss of voltage.

In these uses it is as reliable as any hot wire instrument. Its prime advantage, however, lies in the fact that it may be used as a "zero" instrument.

For example, an alternating current on one pair of suspension wires may be balanced by a direct current in the other wires, and this may be measured by an ammeter. If a suitable switch be used by which the direct and alternating currents may be exchanged on the suspensions any error of inequality of wires or want of symmetry in the suspensions may be detected and the adjustments corrected.

In a similar manner a direct current voltmeter may be used for the measurement of alternating electromotive forces.

Multiplying resistances, or shunts, with known ratios, may be used with either pair of suspensions, increasing or decreasing the readings of the instrument used as an ammeter or voltmeter, at will. The connections are obvious and need no description.

In this way it is possible to measure alternating currents or pressures with direct current instruments, using the hot wire as an indicator simply, under conditions which involve neither temperature nor calibration errors.

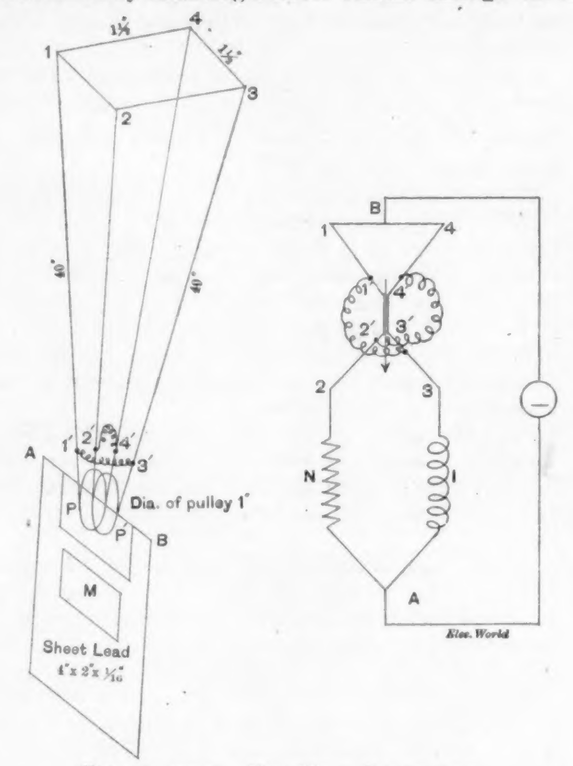
The sensitiveness may be estimated from the fact that with the instrument described above, which was designed for comparatively large currents, eight volts gave a deflection of 256 millimetres on the scale at the distance of one metre. The calibration curve is parabolic in form, like that of the Cardew voltmeter, one volt giving about four and one-half millimetres. The instrument can easily be adjusted to a sensitiveness ten times as great. Many similar applications will suggest themselves to the laboratory worker.

The instrument has been used to measure coefficients of self-induction by a modification of Joubert's method. For this purpose the two suspensions are joined differentially in an alternating current circuit (Fig. 2). The secondary current from a 50-volt transformer was used with a regulating resistance in series.

In circuit with one pair of suspensions 2.2' and 4.4' was a non-inductive resistance of No. 18 German silver wire, variable from 1 to 1,000 ohms by single ohms. In the other branch 1.1' and 3.3' was the inductive resistance. The non-inductive resistance was varied until the currents in the two branches were made equal. When this was the case the instrument showed no deflection, and the impedance of circuit A I B was evidently equal to the resistance of the non-conductive circuit A N B. Let R = the resistance of the inductive circuit, R' = that of the non-conductive circuit, including the suspension wires in both cases. Let L = the coefficient of induction of the coil, n = the number of alternations per second, and p = the "pulsation" = $2\pi n$. Then

$R' = \sqrt{R^2 + p^2 L^2}$ and $L = {}^1\sqrt{R'^2 - R^2}$ and L is known from R' and p.

An example will illustrate this use of the instrument. A circular coil of No. 28 wire, wound in a rectangular channel, whose coefficient of induction as computed was .081+ henry, was measured by the above method. R = 76.3, R' = 106.25, $2\pi n = 910$; whence L = .08125. With .25 ampere in the suspension wires of the instrument described above, the variation of .1 ohm in the value of R' could be easily detected. This change in R' would vary L by about one-half of one per cent. The wires of this instrument, however, would easily carry .5 ampere, with which current a much higher degree of sensitiveness could be obtained: but since the speed of the alternator (a 500 light Westinghouse) could not be determined with certainty more closely than one per cent. this higher degree of sensitiveness was not available. In the use of the instrument for this purpose the value of R was generally determined by balancing a direct current through the inductive resistance by an equal one through the non-inductive branch.



FIGS. 1 AND 2.—HOT WIRE VOLTMETER.

In certain cases the non-inductive wire resistance might be replaced by a water resistance with an electrostatic voltmeter.

The apparatus can be used as a speed indicator as is obvious from our formula

$$p = 2\pi n = \frac{1}{L}\sqrt{R_1 - R^2},$$

$$n = \frac{1}{2\pi L}\sqrt{R'^2 - R^2}.$$

With the apparatus used in the experiment described above a variation of five revolutions per minute in the speed of the alternator (about 2,200) is clearly indicated with a current of .25 ampère, and a current of .5 ampère will show changes in speed of one or two revolutions. Such a degree of sensitiveness cannot be profitably employed except under conditions which secure great constancy in the rate of driving. It is also clear that any degree of sensitiveness may be secured by winding a coil with a large L and a small R.

If the E. M. F. applied to the instrument be kept constant by a variable resistance, R' may be adjusted for the average speed, and variations may be read directly from a calibrated scale.

A capacity may be measured in the same way as an inductance if we put the condenser in series with one pair of suspension wires in the place of the inductive resistance. The non-inductive resistance required to produce a balance is given by the formula $R' = \sqrt{R^2 + \frac{1}{C^2 p^2}}$, whence we have

$$C = \frac{1}{p\sqrt{R'^2 - R^2}}.$$

To measure a capacity of one microfarad with an apparatus having dimensions equal to those of the instrument described above, and employing currents with the same rate of alternation, we should require 1,137 ohms for R'. R evidently need be no greater than the resistance of one pair of suspension wires. Also 250 volts would be needed to reach the same degree of sensitiveness as in the experiments on inductance. We can, however, cut down the value of R' by using a higher rate of alternation and diminish the required E. M. F. by using a more delicate suspension.

The accuracy of this method of inductance or capacity measurement is dependent upon our speed indicators.

The most satisfactory method, thus far, has been found in the use of two instruments, one with a coil of known inductance used as a speed indicator, in parallel with a second instrument for the measurement of the unknown inductance or capacity.

Some preliminary experiments have been made looking toward the employment of Dr. Pupin's apparatus for the production of simple harmonic currents of known frequency.

If the apparatus be used to measure the inductance of a circuit containing iron, it must be remembered that L in this case is a variable quantity, depending upon the value of the current. This fact enables us to determine the magnetization, or B — H curve of sheet iron or wire, when the lamination is sufficient to practically destroy eddy currents. The iron must be in the form of a closed magnetic circuit, whose length and area of cross-section A is known in centimetres.

It must be wound with a number of convolutions S sufficient to produce the highest induction desired with a current which is within the capacity of the suspension wires, and a reliable voltmeter must be used to determine the E. M. F. applied to the divided circuit.

Then if B_1, B_2, etc.; H_1, H_2, etc.; L_1, L_2, etc.; V_1, V_2, etc.: R'_1, R'_2, etc., and i_1, i_2, etc., are the inductions, forces, inductances, E. M. Fs., impedances and currents in successive experiments,

$$B_1 = \frac{L_1\, c'_1}{S\,A\,.707} = \frac{V_1\,(R'^2 - R^2)^{\prime\prime 2}}{.707\,p\,A\,R'_1\,S}$$

$$\text{and } H_1 = \frac{1.26\,S\,i_1}{.707\,l} = 1.78\,\frac{S\,V_1}{l\,R'_1}$$

and each point of the curve is determined by a voltmeter reading V and a resistance R'.

It would be an easy matter to set up an instrument of this sort for the rapid practical determination of the quality of iron used in transformers and armatures. The use of an observing telescope would not be objectionable here, since a zero method is employed, and there is little in the apparatus to get out of order. The error due to eddy currents may be made quite small, and the conditions of test and actual use for the iron would be approximately the same. The expensive non-inductive resistance for large currents may be dispensed with and a water resistance with a non-inductive ammeter used in its place. Other forms of this instrument, which we have called the "hot-wire balance," have been devised, but the one described, although it is not easily portable, has proved as satisfactory in use as it is simple in construction.

Sparking of Dynamos and Motors.

The "Bulletin de la Societe International des Electriciens," for June, contains an interesting paper, by Mr. Rechniewski, on sparking of dynamos and motors. After discussing the cause of sparking he states that there would be none at all if the current in the coil, while it is short circuited by the brushes, is not only reversed but reaches the value which it will have after leaving the brushes, that is C ÷ 2, in which C is the total current of the armature; at the moment of rupture between the brush and the commutator bar there will then be no variation in the current, and therefore no sparking; it therefore follows that the coil must be past the neutral line and commence entering the field, which field must, however, be very weak at this point, for otherwise the current in the short-circuited coil may become too great; furthermore, this portion of the field must increase as the armature current increases; the field in the neighborhood of this point ought furthermore to increase gradually for successive points on the periphery of the armature, in order that a small error in the position of the brushes does not cause a great difference; a small variation in the armature current ought not to change the field materially, that is, the armature reaction ought to be as small as possible; the self-induction of the armature coils should also be as small as possible; the first of the last three conditions may be met by widening the pole pieces or increasing the air gap, the second, by making the ratio, and not the difference, of the ampère turns of the armature and those of the magnets as small as possible, for by making the difference small, a variation in one will cause this difference to become great; as some of these conditions are antagonistic to good efficiency, one must choose properly between them; in order to reduce the self-induction recourse is had to saturation, as the spark which depends on the change of flux will be less as this change becomes smaller; from this he concludes that a portion of the magnet circuit should be saturated and that this part had better be the armature, and still better the teeth, if there are any. In conclusion, he says that as far as sparking is concerned, drum armatures are preferable for small machines, but for large ones Gramme armatures are better; in comparing multipolar machines in which the windings are in series with those in which they are in parallel, he shows that in the latter the E. M. F. at the rupture of the commutator segment and the brush will be twice as great.

HENRY A. ROWLAND.

Prof. Henry A. Rowland, chairman of the delegates from the United States, was graduated from the Rensselaer Polytechnic Institute, Troy, N. Y., in 1870, when he was barely of age, and a year later began his career of scientific investigator and teacher, which has given him an enviable position among the great scientific names of the century.

His father, the Rev. H. A. Rowland, was a scholar of distinction and of old Connecticut Congregational stock, a graduate of Yale and Andover, and a pastor in the Presbyterian Church for nearly 30 years. It is evident that the genius of the boy soon found its object, for he determined on a scientific course and entered Rensselaer Polytechnic Institute at Troy, from which he was graduated as a civil engineer. The next year found him railroad surveying in Western New York, but his ability as a teacher was already recognized and his services were called into requisition at Wooster University. In 1872 he returned to Rensselaer as instructor in physics, and in 1874 he became assistant professor.

In the meantime he had completed his now widely known experiments on magnetic permeability, but at first he was unable to get them published. The scientific journals in America rejected his work, but, confident of its value, he sent his results to Clerk Maxwell, who at once had them published in the "Philosophical Magazine." He was now becoming known, and when the authorities of the newly founded Johns Hopkins University, at Baltimore, cast about them for some one to fill the chair of physics and become director of the physical laboratory, Prof. Rowland, with his already recognized ability and with the countenance which Maxwell's recognition of his talents gave, was chosen for the place. This was a year before the university actually opened, and the interval he spent in Europe, working in Berlin with Helmholtz. Here he investigated the effect of static electricity in motion, and proved that a moving charge has the effect of a current.

While the energies of Prof. Rowland have been largely devoted to exhaustive researches into the nature and phenomena of electricity and magnetism, his work takes a broad sweep through pretty well the whole range of physics. To the public his name is probably even more familiar in connection with his large diffraction gratings, which are ruled by a method of his own directly on concave mirrors, the image of the solar spectrum being thus produced without the aid of lenses. In fact, the photographs of the spectrum obtained with the aid of these gratings far exceed anything else of the kind, and their exhibition before the National Academy of Sciences in 1883 was one of the leading scientific events of the year.

The well earned degree of Ph. D. was conferred upon Prof. Rowland by Johns Hopkins University in 1880. As a member of the Electrical Congress at Paris in 1881, and of the jury at the Electrical Exhibition at the same time and place, he received the order of a Chevalier of the Legion of Honor. In 1881 he was elected a member of the National Academy of Sciences. In 1883 he presided over the Physics Section of the American Association for the Advancement of Science, at Minneapolis, and read a memorable address, entitled "A Plea for Pure Science." In 1884, being appointed by the government on the commission specially formed for the purpose, he presided over the deliberations of the National Conference of Electricians at Philadelphia, and delivered an address. During the same year he received from the American Academy of Arts and Sciences, of which he is an associate, the Rumford medal for his researches in light and heat, and since then other well merited honors have fallen to his share.

Prof. Rowland is the author of many papers of great importance, most of which relate to his far-reaching researches into various scientific subjects. In addition to developing the resources of the physical and electrical laboratories at Johns Hopkins, where, in addition, an electrical testing bureau has been established by him, Prof. Rowland in some manner continues to devote time to many other matters of importance. He is corresponding member for the British Association for the Advancement of Science, and of the Cambridge Philosophical Society, is one of the twelve foreign members of the Physical Society of London, and is a permanent member of the International Commission for establishing electrical units.

HERMAN VON HELMHOLTZ.

Hermann Ludwig Ferdinand von Helmholtz, Imperial delegate from Germany, was born Aug. 31, 1821, at Potsdam, Germany, where his father occupied the position of a teacher in the gymnasium. His mother was the daughter of a Hanoverian artillery officer named Penne, a lineal descendant of William Penn. In his seventeenth year Helmholtz entered the University of Berlin as a student, and wished to devote himself to the study of physics; but circumstances compelled him to enter upon the study of medicine, a course which was rendered easy for him by the liberal arrangements of the Frederick William Institute, an institution for the training of military surgeons, from which he was graduated in 1842.

In the year 1847 he published in a small pamphlet entitled "The Conservation of Energy" the views that have revolutionized scientific methods of thought, and placed his name among those greatest in science in all ages. From this time on his name is connected with many of the great scientific advances of the last half century, among which were the discovery of the principle of the ophthalmoscope and a series of researches in physiology, pathology and optics. In 1871 he accepted the chair of physics in the University of Berlin, and from this time forward was chiefly engaged in inquiries in the great departments of electricity and hydro-dynamics.

The first investigation in this field was in regard to whether forces exist acting at a distance without an intervening medium. The aim of Helmholtz in this direction "had been to determine in what direction experiments should be made to decide between the various theories. He succeeded in making such an experiment on the electricity collected on the surface of a conductor rotating in the magnetic field. This experiment decided in Faraday's favor." The second great problem whose elucidation Faraday had in mind, namely, the relation between electrical and chemical forces, stimulated Helmholtz to a series of important investigations. He was able, by means of the mechanical theory of heat, to calculate (in the case of a solution of salt) the effect of water on the electromotive force. In this way he came to the investigation of the thermo-dynamics of chemical process, and solved the general problem What portion of the energy present in any system can be transformed into another kind? He arrived at the result that all chemical compounds below their dissociative temperature give off heat, if produced in the reverse manner. In a highly ingenious manner he showed the reflex effects of the ether and ponderable atoms on each other, in his work on "The Theory of Abnormal Dispersion." Having in 1888 already shown the remarkable analogy of the vortex motions of water with the electro-magnetic effects of electric currents, he now applied the theory of friction of solid bodies to that of flowing extremely thin films of fluids, and thus created an analogy between electro-dynamics and hydro-dynamics (1879). He also introduced the conception of "electrical convection," viz., "The Transmission of Electricity by the Movement of Its Ponderable Conductors" (1876). He showed that the law of constancy of energy makes it possible, without the aid of any hypothesis as to the internal constitution of electrically or magnetically polarized bodies, to find the effect of the pondero-motor forces acting on the interior of such bodies, and causing changes of form. The conclusion is that the hypothetical system, assumed by Faraday, of tensions acting along, and pressure at right angles to, the lines of force, actually exists and acts in such bodies.

Though we have only touched but briefly on some of the most important of Helmholtz's researches, scarcely a region throughout the whole domain of nature has been left altogether unassailed by him.

In the autumn of the year 1887 the German Empire founded a physical-technical institution, Dr. Werner Siemens having given for the purpose a sum of £25,000. The institute comprises two departments, one for purely scientific purposes, and the other concerned with the application of scientific physics to technical purposes. The first is a laboratory for the advancement of pure science. The second department has for its object to develop technical-scientific methods and appliances, and to keep industry abreast of the progress of science. Over this great and important new institution Helmholtz was chosen by the government to preside, while he was further appointed director of the first, or purely scientific, department. In consequence, he resigned the chair of physics and the directorship of the Physical Institute of Berlin, though he still retains the position of professor ordinarius in the university, and delivers lectures on special subjects of theoretical physics. In 1883 the German Emperor conferred on Herr Helmholtz and on his family the honor of hereditary nobility.

E. E. N. MASCART.

Eleuthin Elu Nicolas Mascart, delegate from France, was born at Quarouble (Nord), France, on Feb. 20, 1837. He studied at the College of Valenciennes, and, after graduating there, became tutor at the lycées of Lille and Douai at the age of 19. In 1858, in order to complete his studies, he entered the Ecole Normale Supérieure, and, after completing the course, remained until 1864 as *préparateur*, or assistant professor.

In 1865 he was called to the chair of physics in the Lycée at Metz, and shortly after to the same chair at Versailles. His merits being constantly more recognized, he was called upon in 186' to take the adjunct professorship of physics at the College of France, beside the celebrated Regnault, and on the decease of the latter he succeeded to the full professorship.

During the Franco-Prussian war, M. Mascart undertook the sub-directorship of the cartridge and chassepot factory at Bayonne, and at the end of the war was created Chevalier of the Legion of Honor. In 1878 M. Mascart was appointed director of the Central Meteorological Bureau of France, a position which he still holds with much credit. In 1884 M. Mascart was elected a member of the French Academy of Sciences.

The scientific writings and publications of M. Mascart are quite numerous, and all of eminent value. His first work was published in 1884, and was a memoir entitled "Researches on the Ultra-Violet Solar Spectrum and the Determination of the Wave Lengths of the Luminous and Ultra-Violet Rays." Since then he has given to the world a large number of memoirs, especially on light and electricity.

In 1876 M. Mascart published his "Treatise on Static Electricity," in two volumes, and between 1882 and 1886 the well known work entitled, "Lessons in Electricity and Magnetism." This work, in which M. Joubert collaborated, has been translated into the English and German languages. M. Mascart's latest work is his great "Treatise on Optics," and, like all his preceding works, it has at once taken the place of a standard authority on the subject.

Naturally, a man of M. Mascart's abilities would be much sought after as a representative in scientific circles. Thus he has been twice president of the French Physical Society and similarly of the Société Internationale des Electriciens and president of the French Meteorological Society, also vice president of the Consulting Committee on Arts and Manufactures attached to the French Ministry of Commerce.

At the Paris Electrical Exposition and Congress of 1881 M. Mascart was general reporter of the Congress and of the jury, for which services he was created Officer of the Legion of Honor.

In connection with the French Exposition of 1889, M. Mascart was president of the Technical Committee on Electricity, president of the jury of Class 62 (electricity) and finally president of the Interntional Congress.

GALILEO FERRARIS.

Prof. Galileo Ferraris, delegate from Italy, was born in Livorno-Marcellese, a small town of Northern Italy, near the end of the year 1847. Following the natural inclination of his mind, he took the courses in mathematical and physical sciences at the University of Turin, from which he was graduated in the year 1869.

Prof. Ferraris early gave proof of his talent and studious disposition, writing a pamphlet on teledynamic transmission when he was not yet 22 years old; it is, therefore, not surprising that after obtaining his degree, Prof. Codazza, professor of physics at the Superior School of Engineering, chose the brilliant scholar as his assistant, and that shortly afterward he was made a member of the College of Professors of the University of Turin, to which the engineering school is attached. A little later he succeeded Prof. Codazza as professor of physics, which position he holds at the present time.

Prof. Ferraris in the early part of his career turned his attention particularly towards mathematical physics, and above all to geometrical optics. Some of the results of his studies and researches in the latter branch are embodied in a paper read before the Academy of Sciences of Turin on "Telescopes Having One Objective Composed of Several Glasses Separated from Each Other," and in a treatise entitled "Cardinal Properties of Dioptric Instruments," a work which was translated into German and is yet a text-book in several German universities.

But if the studies and researches of the young professor were at that time especially devoted to optics, it does not follow that he neglected the other branches of physics; even at that early day his attention was directed toward electricity, and shortly after graduation he wrote a paper "On the Mathematical Theory of the Transmission of Electricity in Homogeneous Solids," but the first important work in this field was an experimental and theoretical memoir, published in 1879 by the Academy of Sciences of Turin, on the telephone and telephonic circuits, in which were given measurements of intensity and self-induction effects—a paper largely cited by Wiedemann in his great treatise.

In 1881 Prof. Ferraris was the representative of the Italian government at the Paris Electrical Exhibition and Congress, on which he wrote a report. In 1882 he was one of the representatives of Italy at the Paris Electrical International Conference, and also at the Vienna Exhibition of 1883. He organized and presided at the International Electrical Exhibition at Turin in 1884, and there made his first experiments on the Gaulard and Gibbs transformer, which led to his taking up the study of alternating currents. These experiments made matter for a paper entitled "Theoretical and Experimental Researches on the Gaulard and Gibbs Secondary Generator."

A little while later Prof. Ferraris experimented with a Ganz transformer, and was led by theoretical considerations to the conception of the magnetic rotary field obtained by two or more alternating currents having difference of phase, and proved his theoretical views by experiments in the laboratory of the Industrial Museum of Turin in August, 1885. Some of the apparatus used in these experiments are now in the World's Fair historical exhibition of the American Institute of Electrical Engineers. Although these results were known to friends of the professor and to the pupils who followed his lectures at that time, they were not published until the beginning of 1888, in a paper read before the Academy of Sciences of Turin.

The use of multiphase alternating currents for the production of a magnetic rotary field led Prof. Ferraris to study questions relating to difference of phase and methods of measuring the same, the experimental and theoretical results of which were published in 1887 in a memoir entitled "On Differences of Phase in Currents, On the Retardation of Induction, and On the Waste of Energy in Transformers."

In 1886 Prof. Ferraris was appointed by the Minister of Public Instruction to deliver a course of lectures on electricity to graduate engineers at the Industrial Museum of Turin. These lectures, to which the Professor has devoted a great deal of his activity, were a marked success from the beginning; the attendance increased from year to year, and at present the lectures furnish the leading course of electrotechnics in Italy. These lectures are models of their kind and of the highest scientific character. Their conciseness, a charming literary form, and especially their expression of the deep feeling and enthusiasm of the devoted man of science, cause them to be interesting to an unusual degree and make those who have attended the course proud of the honor of having been pupils of Prof. Ferraris.

Prof. Ferraris is a member of a number of the learned societies of Europe. He was one of the vice-presidents of the Electrical Congress at Frankfort, and is the sole Italian government delegate to the International Electrical Congress at Chicago.

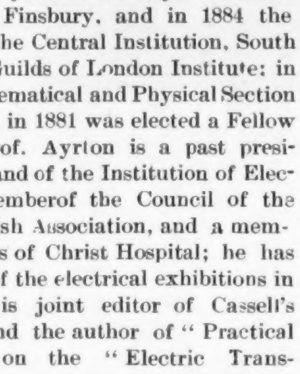
W. E. AYRTON.

Prof. W. E. Ayrton, F. R. S., delegate from Great Britain, was educated at University College School, where he gained numerous prizes and entering subsequently into the college gained the Andrews Exhibition in 1865 and the Andrews Scholarship in 1866.

Passing the examination with honors for his first B. A. in 1867, Mr. Ayrton in the same year came out first in the entrance examination for the Indian Government Telegraph Service. He was then sent by the Secretary of State for India to study electrical engineering with Prof. Sir William Thomson, coming out first at the advance examination for the Indian Government Telegraph Service, and won the scholarship. When in India Prof. Ayrton acted first as the assistant electrical superintendent, and subsequently as the electrical superintendent in the Government Telegraph Department, introducing, with the late Mr. Schwendler, throughout British India, a complete system of immediately determining the position of a fault in the longest telegraph line by electrically testing at one end. In 1872-3 Prof. Ayrton was on special duty in England on behalf of the Indian Government Telegraph Department, and in charge of the Great Western Telegraph manufactory in London, on behalf of the engineers, Prof. Sir William Thomson and the late Prof. Flemming Jenkin. From the latter year until 1879 Prof. Ayrton was the professor of natural philosophy and of telegraphy at the Imperial College of Engineering, Japan, the largest English-speaking technical university in existence at that date. In 1879 he was appointed professor of applied physics at the City and Guilds of London Technical College, Finsbury, and in 1884 the chief professor of physics at the Central Institution, South Kensington, of the City and Guilds of London Institute: in 1880 a secretary of the Mathematical and Physical Section of the British Association, and in 1881 was elected a Fellow of the Royal Society. Prof. Ayrton is a past president of the Physical Society and of the Institution of Electrical Engineers, and is a memberof the Council of the Royal Society and of the British Association, and a member of the Council of Almoners of Christ Hospital; he has been a juror in the majority of the electrical exhibitions in England and abroad, and is joint editor of Cassell's "Manuals of Technology," and the author of "Practical Electricity." His lecture on the "Electric Transmission of Power," given at the meeting of the British Association at Bath in 1888, was so much appreciated that, at the request of the town, this lecture was repeated to an audience of 3,000, the first time in the annals of the British Association that one of their lectures has been repeated. With Prof. Perry he is the joint inventor of the well known ammeters, voltmeters, electric power meter, ohmmeter, dispersion photometer, transmission dynamometer, dynamometer coupling, governed electric motor, oblique coiled dynamo machine, and secohmmeter; and, with the late Prof. Fleeming Jenkin and Prof. Perry, of the system of automatic electric transport known as "telpherage." About one hundred papers published in the "Proceedings and Transactions" of the Royal Society, Physical Society, Society of Telegraph Engineers and other societies have been contributed by Prof. Ayrton conjointly with Prof. Perry and others.

EMIL BUDDE.

Dr. Emil Budde, Imperial delegate from Germany, was born at Geldern, Prussia, July 21, 1842, and studied at Bonn, becoming later lecturer at that University. He resigned the position in 1870, and took up journalism. Upon the outbreak of hostilities between France and Germany he acted for a time as war correspondent for the "Kölnische Zeitung"—the "Times" of Germany,—relinquishing that arduous and somewhat uncertain post, in response to a special call, for the cushions and comfort—what there was—of the editorial chair in Cologne, which he occupied for a period of some six or seven months. Finding it, however, too monotonous for his tastes, Dr. Budde elected to act as foreign correspondent to the journal, visiting successively in that capacity Paris, Rome and Constantinople.



Dr. Budde afterward traveled over a large part of northern Africa and the East, and the accounts which he sent home to his paper of his experiences and observations on men and things, written in a characteristic and pleasing style, have recently been collected and republished in book form under the appropriate title: "Blätter aus meinen Skizzenbuc" (leaves from my sketchbook). Other works of his of the same kind are: "Reiseskizzen aus Palestina," "Erfahrungen eines Hadschi," etc.

During his sojourn abroad Dr. Budde did not neglect his scientific studies, and on his return to Europe became a frequent contributor to "Wiedemann's Annalen" and other technical periodicals. Dr. Budde is also the autho of an exhaustive treatise on mechanics for the use of students, and a series of popular essays on miscellaneous scientific subjects entitled: "Wissenschaftliche Plaudereien."

In 1878 Dr. Budde went to Berlin and for some time edited the "Fortschritte der Physik." In 1892 he joined the staff of Messrs. Siemens & Halske in Berlin as consulting physicist, a position which he holds at the present time. It may be mentioned here that Dr. Budde was proposed last year for the appointment of Director of the Technical Department of the Reichsanstalt in Charlottenburg, although his election did not follow. Dr. Budde holds the general secretaryship of the new "Verband Deutscher Elektrotechniker," and was mainly instrumental in the founding of the society.

HENRY S. CARHART.

Henry Smith Carhart, A. M., delegate from the United States, professor of physics and director of the physical laboratory of the University of Michigan, was born at Coeymans, near Albany, N. Y., in 1844. His people were farmers, and when only 16 he taught a district school for funds with which to enter college. During his preparation for college at the celebrated Hudson River Institute, at Claverack, N. Y., he taught one year as principal of a small Quaker school near Poughkeepsie. In 1865 he was examined and admitted to Yale, but by the advice of his friends took the course instead at Wesleyan University, Middletown, Conn. From this institution he received the degree of A. B., and later that of A. M., being valedictorian and also first honor man in several subjects. After graduation he taught two years at Claverack, then took one year's post-graduate work at Yale, which was followed after some time by study at the Harvard summer school of chemistry.

In 1872 Mr. Carhart was called to the Northwestern University as instructor in civil engineering and physics In 1873 he was made professor of physics and remained there, until, in 1886, he was called to the same chair at the University of Michigan. A year's leave of absence was granted him in 1881 which he spent in physical study under Prof. Helmholtz at the University of Berlin. At this time he was appointed upon the international jury of award at the Paris electrical exhibition.

Prof. Carhart has been for many years an active member of the American Association for the Advancement of Science, has written much for both American and English scientific journals, and lectured on subjects connected with his line of work in many of the large cities of the country, and is in great demand as an electrical expert in cases where such testimony is of especial importance. His book, "Primary Batteries," is an authority upon the subject, and the Professor has been a frequent contributor to leading scientific and technical journals.

Prof. Carhart was invited to sit as a member of the British Association Committee on Electrical Standards in Edinburgh last August. He has received the degree of LL. D. from his alma mater, Wesleyan University, during the present year, and besides being one of the U. S. Delegates to the International Congress is president of the Committee of the Judges of Awards for the Department of Electricity.

EDOUARD HOSPITALIER.

Edouard Hospitalier, delegate from France, was born in Sedan (Ardennes), on Aug. 24, 1852. He received his diploma of Bachelier-ès-Sciences in 1870, and then attended the Ecole Nationale des Arts et Métiers and the Ecole Centrale des Arts et Manufactures, receiving the degree of mechanical engineer.

Prof. Hospitalier in 1880 became a member of the editorial staff of "La Lumière Electrique," and founded "L'Electricien" in April, 1881, which he edited until 1891, when the first number of "L'Industrie Electrique" was issued under his direction. He is now editor-in-chief of the latter journal and professor of electricity at the Ecole de Physique et de Chimie Industrielle of the city of Paris, the first course of industrial electricity founded in France.

Besides being one of the active founders of the Société Internationale des Electriciens, of which he is now the vice-president, Prof. Hospitalier has always taken a leading part in its proceedings and the various measures connected with it, including the founding of the Laboratoire Central d'Electricité.

Prof. Hospitalier has always taken a lively interest in the various electrical congresses and exhibitions, and was vice-president of the Frankfort International Electrical Congress. He has paid particular attention to the subject of units, and his labors of years toward securing uniformity in the symbols and notation of electrical science will probably receive their final reward at the Chicago Electrical Congress, as they have already received universal recognition aside from official action.

As a writer on electrical subjects Prof. Hospitalier is unequaled. Whether writing for the popular reader or for the electrical public he displays the same conscientious care of statement; his grasp of details and keenness for the practical bearings of a subject, as well as the absolutely independent character of his opinions, are points that place his writings in the highest rank of technical literature. Of his works "The Principal Applications of Electricity," "Domestic Electricity," and "Polyphase Currents" have been translated into English. The "Formulaire des Electriciens," which is found on the desk of many America-electricians, was first published in 1883; since then a new edition has been issued yearly and the singularly practical judgment shown in the selection of its contents has received international recognition.

Prof. Hospitalier is possessed of a genial character, and is cosmopolitan in his views and sympathies. He is a most indefatigable worker, tenacious in his purpose, and absolutely independent in his opinions. From his devotion to scientific truth and faculty of getting at the essential facts of subjects, and also a frank and direct manner of expressing his opinions, it is needless to say that stock jobbing and other electrical sham schemes receive little mercy at his hands. One instance of this is his controversy with Marcel Deprez extending over five or six years, and others might be noted.

OTTO LUMMER.

Dr. Otto Lummer, Imperial delegate from Germany, was born at Gera, July 17, 1860, and studied in Tubingen and Berlin, graduating at the latter university in 1884. In the same year he was appointed assistant under Prof. von Helmholtz, in the Physical Institute, Berlin; and upon the establishment of the Physikalisch-Technische Reichsanstalt was transferred there in the same capacity. He was elected member in 1890, and has since conducted with marked ability and success the optical department of the famous Reichsanstalt.

Dr. Lummer's work has been entirely special in the line of optical research; the results have been published for the most part in "Wiedemann's Annalen" and the "Zeitschrift fur Instrumentenkunde," among the more important papers may be mentioned: "Ueber eine neue Inferenz-Erscheinung an planparallelen Glasplatten und eine Methode die Planparallelitat solcher Glaser zu prufen"; "Ueber eine neue Inferenzerscheinung"; "Ueber die Theorie und Gestalt neubeobachteter Inferenzcurven." Dr. Lummer's name, however, will be most familiar, outside of Germany, at least, in connection with the photometer, his invention having placed photometry for the first time on a new basis since the well known Bunsen experiments. Dr. Lummer's valuable investigations in this field of research, with special reference to the determination of a standard unit of light, will form the subject of his lectures in America.

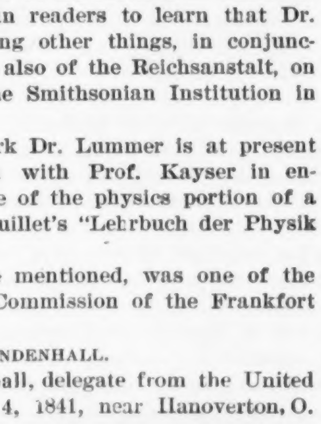
It will interest American readers to learn that Dr. Lummer is engaged, among other things, in conjunction with Dr. Pringsheim, also of the Reichsanstalt, on some private work for the Smithsonian Institution in Washington.

In scientific literary work Dr. Lummer is at present occupied in collaboration with Prof. Kayser in entirely re-writing the whole of the physics portion of a new edition of Mueller-Pouillet's "Lehrbuch der Physik und Meteorologie."

Dr. Lummer, it may be mentioned, was one of the members of the Testing Commission of the Frankfort Electrical Exhibition.

T. C MENDENHALL.

Thomas Corwin Mendenhall, delegate from the United States, was born on Oct. 4, 1841, near Hanoverton, O. On his father's side he is of Quaker stock, tracing his descent from Benjamin Mendenhall, who emigrated from England with William Penn, and settled in Pennsylvania. Young Mendenhall's schooling was of the scanty kind afforded by small country villages more than a generation ago; defective though it was, it developed in him at an early age a fondness for the study of mathematics and the natural sciences, and he gradually won for himself an education which his opportunities would have denied to a less sturdy spirit.



In 1873, on the organization of the Ohio State University, he was elected to the chair of physics and mechanics, which he held until 1878, when he accepted the professorship of physics in the Imperial University of Japan at Tokio. While in Japan he organized a special course in physics, and established a physical laboratory in connection with the science department of the university. In addition he founded a meteorological observatory, and furthermore carried out an investigation on the force of gravity at the sea level and on the famous Japanese extinct volcano Fujinoyama. His measurements of the figure of the mountain and of its density enabled him to deduce a value for the mass of the earth which agrees very closely with that of Francis Baily as obtained by the Cavendish method. About this time he also made a series of elaborate measurements of the wave lengths of the principal Fraunhofer lines of the solar spectrum. He also aided in founding the Seismological Society of Japan, and has since established the systematic gathering of seismological data in the United States.

In 1881 Prof. Mendenhall returned to the United States and resumed his chair at the Ohio State University. In the following year he organized the Ohio State Weather Service, of which he was director until 1884, when he received an appointment in the United States Signal Service at Washington. Here he organized and equipped a physical laboratory in connection with the office of the Chief Signal Officer, and inaugurated systematic observations of atmospheric electricity.

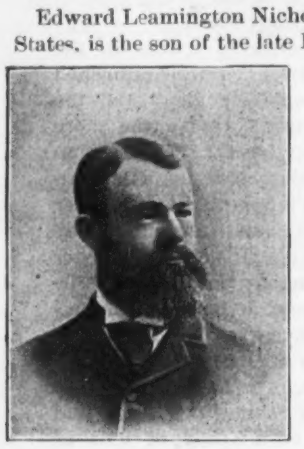
After two years' service of the government he resigned to accept the presidency of the Rose Polytechnic Institute in Terre Haute, Ind., and in 1880 was made superintendent of the United States Coast and Geodetic Survey, the position he now fills as well as the equally important one of Superintendent of Weights and Measures.

Prof. Mendenhall is the author of a widely known book, "A Century of Electricity," as well as of numerous scientific papers published in scientific journals or read before the National Academy of Sciences and the American Association for the Advancement of Science, the latter of which he has served as president. The honorary degree of Ph.D. was conferred on him by the Ohio State University in 1878, and that of LL.D. by the University of Michigan in 1887. In the latter year he was chosen a member of the National Academy of Sciences.

More recently Prof. Mendenhall has served as a member of the Behring Sea Joint Commission by appointment of the President, and at present is a Commissioner representing the United States in the joint survey of the Alaska boundary line and for marking the boundary line between the United States and Canada in Passamaquoddy Bay, and a member of the Light House Board.

EDWARD LEAMINGTON NICHOLS.

Edward Leamington Nichols, delegate from the United States, is the son of the late Edward W. Nichols, of New York City, and was born thirty-nine years ago. His father was a well known landscape painter, and it was, therefore, owing mainly to his natural bent that the son turned to science. He was prepared for college at the Peekskill Military Academy, and entered Cornell University in 1871, at the age of seventeen. Here he studied under Prof. W. A. Anthony, then at the opening of his long and successful career in the chair which his pupil, Nichols, was to be called upon to fill fifteen years later.



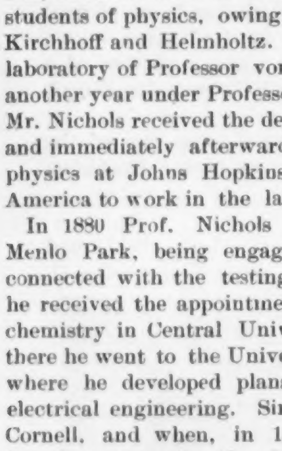
After graduating from Cornell in 1875, Mr. Nichols went to Germany to continue his studies in physics. He first spent a year at Leipzig under the Wiedemanns, father and son, and then went to Berlin, at that time the Mecca of students of physics, owing to the presence there of both Kirchhoff and Helmholtz. Two years were passed in the laboratory of Professor von Helmholtz, and then part of another year under Professor Listing, of Göttingen. Here Mr. Nichols received the degree of Doctor of Philosophy, and immediately afterward he was appointed fellow in physics at Johns Hopkins University and returned to America to work in the laboratory of Prof. Rowland.

In 1880 Prof. Nichols joined the Edison forces at Menlo Park, being engaged chiefly upon the problems connected with the testing of incandescent lamps until he received the appointment of professor of physics and chemistry in Central University, Richmond, Ky. From there he went to the University of Kansas, at Lawrence, where he developed plans for establishing a course of electrical engineering. Similar steps had been taken at Cornell, and when, in 1887, Prof. Anthony resigned his chair to enter the field of commercial electricity, Prof. Nichols was promptly sought by the authorities of his alma mater to fill the vacancy.

Prof. Nichols is the author of many papers and memoirs, chiefly upon experimental physics, which have appeared in the "Annalen der Physik und Chimie," the "Philosophical Magazine," the "American Journal of Science," "Nature," and the "Transactions" of the several scientific societies.

ADRIEN PALAZ.

Adrien Palaz, delegate from Switzerland, was born July 20, 1863, at Riex, a little village on Lake Leman, several miles from Lausanne, in French Switzerland. After studying in the gymnasiums of Burgdorf and Lausanne he entered, in October, 1880, the Federal Polytechnic School, where he paid particular attention to mathematics, mechanics and physics. Upon the completion of the four years' course he received a diploma, but remained at the school to pursue special studies in electricity in the electrotechnical laboratory of Prof. H. F. Weber.



It was in this laboratory that M. Palaz made his researches on dielectrics, through which, in 1885, he obtained the degree of Doctor from the University of Zurich. An account of these researches was published in a paper in 1886 in the "Journal de Physique" of Paris, and in the "Archives des Sciences Physiques" of Geneva.

In August, 1885, M. Palaz entered as engineer the Central Telephonic Service of the Swiss Confederation, at Berne, where he familiarized himself especially with the methods of simultaneous and long distance telegraphy and telephony. However, this branch of electricity not being entirely to his personal tastes, he accepted, in May, 1886, the place of attaché in the Bureau Internationale des Poids and Mesures at Sèvres, near Paris, and a little later became one of the editors of "La Lumière Electrique." In this manner he was enabled to devote the greater part of his time to electrical studies and at the same time actively participate in the works of great precision that have given universal renown to the International Bureau of Weights and Measures.

At the commencement of 1889 M. Palaz was called to a professorship at the University of Lausanne, then in process of transformation; at first he taught mathematical physics, but a little after organized a course and laboratory of industrial electricity for the engineering school forming part of the university, and at present occupies the position there of professor of industrial electricity.

Besides his duties as a professor M. Palaz has extended his activities to the electrical industries, and as an electrical consulting engineer he has been connected with the greater number of the large electrical installations that have been made in Switzerland. He occupies himself particularly with questions relating to the transmission of power and the utilization of water powers for electrical traction. At present he is engaged on a study for an electrical railway to compete with lines passing through the tunnels of St. Gothard and Mont Cenis. This projected international electrical railway between Switzerland and Italy will cross the Alps at the Simplon Pass and has a length of 52 kilometres, with grades of 60 per cent., and will employ the Abt rack and pinion system.

Besides the theoretical and practical work above mentioned, M. Palaz has published several scientific and technical works, among which are his "Traité de Photometric Industrielle Appliquée a l'Eclairage Electrique," published in 1892 at Paris, and his "Cours d'Electricité Industrielle," published at Lausanne in the same year. The last work is based upon a series of lectures given to the engineers of the Jura Simplon Railway Company in 1892; at present it is out of print, but a new edition is in preparation.

M. Palaz continues to occupy himself with electrical journalism, and, besides being a collaborator on the "Revue Scientifique" and other journals, has, since he ceased his connection with "La Lumière Electrique," been one of the committee of editors of "L'Electricien."

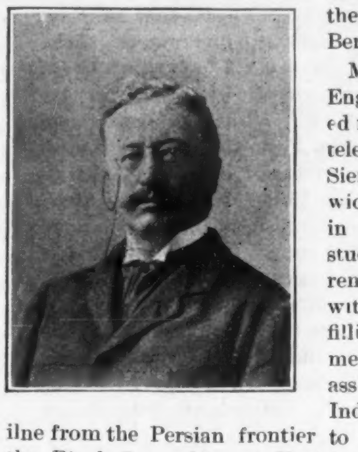
W. H. PREECE.

W. H. Preece, delegate from Great Britain, was born in 1834, near Carnarvon, North Wales, and educated at King's College, London. He entered Mr. Edwin Clark's (M. I. C. E.) office in 1852, and was appointed to the E. and I. T. Co. in 1853, superintendent of the Southern District of E. and I. T. Co. in 1856, of the L. and S. W. Railway Co. in 1860, and of the English Channel Islands Telegraph Company in 1858. He was transferred to the Post Office as divisional engineer in 1870, appointed electrician in 1877, and engineer-in-chief and electrician in 1892.

The remarkable gifts of Mr. Preece as a lecturer on science have brought him prominently before the general public, which crowds to the halls of the Society of Arts or the Royal Institution whenever he is discoursing on some of the electrical topics of the hour, or explaining the mysteries of some inventive marvel. His original researches for the furtherance of the special science which he cultivates, and his various practical inventions, have also won the suffrage of his fellow workers, and have given him a leading place among them. Moreover, the active interest which he manifests in all that relates to his profession and the genial good-humor of the man are of themselves enough to make him popular with electricians, Mr. Preece is also consulting electrician to the British and Colonial governments. He is a Member of the Council of the Institution of Civil Engineers, to which he was elected in 1859. He is a fellow of the Royal Society, a member of the Physical Society, Meteorological Society, the Royal Institution, the British Association and the Society of Arts. He was president of the Society of Telegraph Engineers for the year 1880, and was again elected president of the same society (now called the Institution of Electrical Engineers) for 1892. He is a fellow and a member of the Council of King's College and an honorary member of the American Institute of Electrical Engineers. Mr. Preece is the inventor of a new method of duplex telegraphy, patented in 1855; a new mode of "terminating" wires (1858); working miniature signals by electricity to assimilate electric signals with outdoor signals on railways (1862); the application of electricity to domestic telegraph purposes (1864); the application of electricity for signaling between different parts of a train in motion (1854); locking signals on railways by means of electricity (1865); improvements in railway signaling to counteract the effects of lightning (1873); a new telephone (1878), and improved communication between passengers and guard (1882). He is a joint author with Mr. (now Sir James) Sivewright of a "Text-book of Telegraphy," and with Dr. Maier of "The Telephone"; has edited several works, and written numerous papers for the scientific press.

ALEXANDER SIEMENS.

Alexander Siemens, delegate from Great Britain, was born at Hanover in 1847, and educated at the Lyceum and the Polytechnic College there and at the University, Berlin.

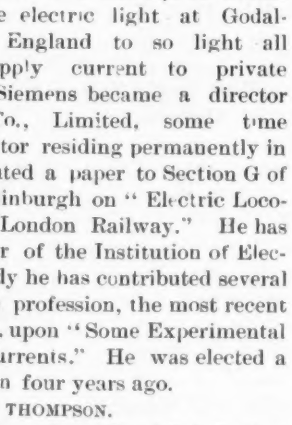


Mr. Siemens went to England in 1867, and worked for a short time at the telegraph factory of Messrs. Siemens Brothers at Woolwich. He went to Berlin in the following year to study at the University and remained there until 1870, with the exception of fulfilling a temporary engagement, during which he assisted in constructing the Indo European telegraph line from the Persian frontier to Teheran and in laying the Black Sea cables at Kertch and from Sukhum Kale to Sotcha.

At the conclusion of the Franco-Prussian war, during which he received the Iron Cross for bravery, Mr. Siemens was again able to continue his scientific studies, and went to England, where he became a pupil of the late Sir William Siemens. In 1873-4 he was conducting experiments for Sir William at Birmingham with a rotary furnace to produce wrought iron and steel direct from the ore. In 1875 Mr. Siemens joined the cable ship Faraday, belonging to Sir William's firm, and took part in several cable laying and repairing expeditions. While the ship was stationed at Halifax, N. S., he built some blast furnaces at Londonderry, N. S., for the Steel Company of Canada, and superintended the erection of a rotary furnace at Pittsburgh, Pa., U. S. A. Returning to England in 1877 he was employed in erecting regenerative gas furnaces for various purposes in different parts of England for Sir William Siemens, among them being the first continuous working tank glass furnace erected in that country. In 1879 he became actively engaged in electrical work for Messrs. Siemens Brothers, and among the first electric light installations made were those at the Albert Hall, the British Museum, the Albert Docks, and the Blackpool Prome nade. He also installed the electric light at Godalming, the first town in England to so light all its thoroughfares and supply current to private consumers. Mr. Alexander Siemens became a director of Siemens Brothers & Co., Limited, some time ago, and is now the only director residing permanently in England. In 1892 he contributed a paper to Section G of the British Association at Edinburgh on "Electric Locomotives on the City & South London Railway." He has been for many years a member of the Institution of Electrical Engineers, to which body he has contributed several papers of great interest to the profession, the most recent being that read on Feb. 11, 1892, upon "Some Experimental Investigations of Alternate Currents." He was elected a vice-president of the Institution four years ago.

SILVANUS P. THOMPSON.

Silvanus P. Thompson, delegate from Great Britain, is a native of York, England, where he was born in 1851. His early education was at the Friends' school in his native place, but he afterward studied at the London University, taking the degree of A. B. in 1869. Even then his attention was turned to science rather than to literature, and he went on with his studies with a view of beginning the academic career that he has followed. Chemistry and physics were his special and favorite studies, and after leaving London University he studied at the Royal School of Mines, and later for short periods at Heidelberg and other foreign institutions. In 1875 he was graduated as Bachelor of Science in the University of London, and three years later took the degree of D. S. C., experimental physics being his special subject. In that year he went to Bristol University College as professor of experimental physics, and there began that course of popular lectures on practical subjects that have gained so much fame for him since.



He delivered during 1878 a course of lectures on technical applications of electricity, and a little later organized the thoroughly equipped physical laboratory at that college.

Prof. Thompson's widest reputation among practical men, however, has been gained by his studies of applied electricity, especially with reference to electrical mechanism. He worked for a time on electrical storage, and very soon after the electric light began to come to public notice made a careful investigation of the theory of dynamo-electric machines, which was embodied in his Cantor lectures before the Society of Arts, which were delivered in the autumn of 1883. They were the first attempt to put the subject in clear popular form and received the widest recognition. About the same time appeared the first edition of his remarkable little book, "Elementary Lessons in Electricity and Magnetism," which as a textbook has achieved a success almost beyond belief, and remains to-day, with the various revisions it has since undergone, by all odds the best elementary book on the subject. That volume has the record of having reached a circulation of more than 40,000 copies in English alone, besides widely read translations into French, German and Polish.

In 1884 came the important volume on dynamo-electric machines, which is in its fourth edition and has been translated into French and German. Several other important volumes have come from Prof. Thompson's pen, of which we may specially note his biography of Philip Reis, the inventor of the telephone, and the splendid Cantor lectures of 1890 on the electromagnet, followed later by another course on electromagnetic mechanism, less extended but scarcely less interesting.

In 1884, when Prof. W. E. Ayrton was elected to the chair of physics at the City and Guilds of London Central Institution, Prof. Thompson took his place at the City and Guilds of London Technical College of Finsbury, of which he is now the principal.

In 1889 Prof. Thompson's constant services in the cause of science were recognized by his election as a fellow of the Royal Society, and in 1891 he was elected one of the honorary vice-presidents of the Frankfort Electrical Exhibition. At the Frankfort Congress he read a paper on "Alternate Currents." He was also the founder of the Gilbert Club and is one of its honorary secretaries.

For the last two years Prof. Thompson has been giving much attention to the problems of ocean telephony and to the improvement of submarine cables to make them available for rapid signaling.

ELIHU THOMSON.

Elihu Thomson, delegate from the United States, was born at Manchester, England, in 1853, his father being Scotch purely and his mother English, with a French admixture two generations back. In 1858 his parents crossed the Atlantic and settled in Philadelphia. Young Thomson had already, from his earliest remembrance, taken great interest in machinery and its operation, and liked to draw, even before the constructive or creative instinct had manifested itself. At seven he entered school at Philadelphia, and it was not long before he was ready to begin studies in the Central High School, but the age limit there being 13 he had to wait nearly two years.

By the time he had finished his four years' course at the Central High School Elihu Thomson may be said to have mastered a considerable part of what was known of electricity, and his continued experiments in that branch, as well as in chemistry, had fitted him to take a share in the coming development. On leaving the High School he spent about six months in an analytical laboratory in Philadelphia, testing iron ores, etc., but he was recalled to fill the place of assistant in the chemical department of the school. This position, which gave him charge of the chemical laboratory and apparatus, and the conduct of the instruction there, he filled until 1876, being meantime—in 1875—appointed professor of chemistry in the Artisans' Night School, of Philadelphia, where, following a practice begun some years before, he delivered lectures on appropriate scientific topics. Through all this period his leisure was filled with a variety of work, and he built a pipe organ with four sets of pipes and with electro-pneumatic key action; he also took up lens grinding and speculum work, and built a compound microscope with his own hands, including compound achromatic object glasses, eye pieces, condensers, etc. This again was supplemented by work on photographic lenses and glass specula, and, it goes without saying, by the construction of numerous electrical devices, ranging from a glass plate Holtz machine to dynamo-electric machines.

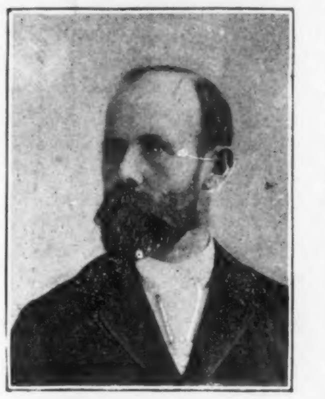
Promotion, and that speedy, was inevitable in the ease of such a worker, and in 1876 Prof. Thomson, only 23 years old, was appointed to fill the chair of chemistry and physics at the Central High School, having charge of the chemical course of two years, and of the teaching in mechanics and in the properties of solids. Prof. Houston had, as he still has, charge of the teaching in the other departments of physics. This professorship was held until 1880, when its incumbent resigned to take the position of electrician to the American Electric Company, of Connecticut, located at New Britain, and now the well-known Thomson-Houston Electric Company, of Lynn, Mass. During its term, however, Prof. Thomson was appointed lecturer at the Franklin Institute, in 1876–7, and gave courses on electricity, etc., that winter, as well as subsequently.

In the winter of 1877–8 Prof. Thomson served with Prof. Houston on a committee of the Franklin Institute on dynamo-electric machines. In 1878 he visited the Paris Exhibition, and studied specially the various electrical exhibits, including the Jablochkoff lighting system, which was then attracting much attention. He returned to America with renewed enthusiasm, and in 1878 and 1879 he applied, jointly with Prof. Houston, for a number of patents on electric lighting apparatus. These formed the nucleus around which the system of the American Electric Company of New Britain was built up.

Upon resigning his professorship and assuming the duties of electrician to the new company, Prof. Thomson removed to New Britain. He now gave his whole time to electrical work and soon after became associated with the Thomson-Houston company; since then his work has become an important part of the history of industrial electricity, and of late years he has made many contributions to pure science.

RENE THURY.

Rene Thury, delegate from Switzerland, was born at Geneva Aug. 7, 1860, and is the youngest son of Prof. M. A. Thury, doyen of the University of Geneva, and well known in the scientific world as a physiologist, physicist, astronomer and engineer. M. Thury was educated in Geneva, where, after his collegiate course, he followed a technical one in the Ecole Industrielle. From 1874 to 1878 he served a regular apprenticeship in the workshop of the Societe Genevoise pour la Construction d'Instruments de Physiques, an establishment founded by his father in 1860. During his apprenticeship his taste for electricity manifested itself more and more, and in 1877 he constructed his first model of a dynamo.



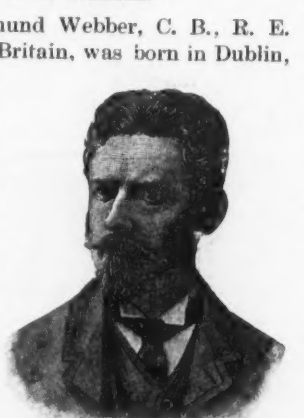
In 1880 he was sent to America to the laboratory of Edison at Menlo Park to study the construction of incandescent lamps by the Societe d'Appareillage Electrique Edison, then being formed, and which desired to make lamps in Switzerland. The society, however, abandoned that idea, and M. Thury returned to Geneva. In 1882 he entered the service of a construction company as engineer; this company afterward united with another one to form La Compaignie de l'Industrie Electrique of Geneva, which has now one of the finest plants on the Continent. From this time M. Thury devoted himself to the study of dynamoes and accessory apparatus, and especially to the great problem of the transmission and distribution of power, so important in Switzerland. His first power transmission plant was installed in 1883, and in it was used the first practical multipolar machine made. Since then more than 1,500 machines have been constructed after this type.

M. Thury is an advocate of continuous currents for the transmission of power, and has developed a system of generators, motors and regulators to carry his ideas into effect. The first application was in October, 1889, at Genoa, Italy, where two circuits of 45 amperes and from 600 to 6,000 volts supply about 25 motors, of which one is 100 h. p., six of 60 h. p., two of 50 h. p., and others varying from 10 to 35 h. p. This installation was begun with a single generator, and is yearly extended, each circuit having now 33 miles. At present M. Thury is engaged on an installation for Paris, where 3,000 h. p. will thus be distributed from two stations.

In 1890 the International Jury in charge awarded him the first prize for his plan for utilizing the power of the Falls of Niagara. M. Thury proposed the employment of continuous currents furnished by generators of 2,500 h. p. of 180 revolutions per minute. The Cataract Company, however, preferred to adopt alternating currents, with generators of 5,000 h. p. and 250 revolutions per minute.

MAJOR-GENERAL C. E. WEBBER.

Major-General Charles Edmund Webber, C. B., R. E. (retired), delegate from Great Britain, was born in Dublin, Sept. 5, 1838, and educated at the Royal Military Academy, Woolwich; he obtained his first commission in the Royal Engineers in April, 1855. General Webber's war services comprise the Indian Mutiny, 1857 to 1859, and services in Zululand, Natal, and later in the Transvaal with the Egyptian Expedition of 1882, as staff officer for telegraphs; he was present at the battle of Tel-el-Kebir, A. A. and Q. M. General and Director of Army Telegraphs with the Nile Expedition of 1884–85, until invalided in May, 1885, and was retired from the service with the honorary rank of major-general in 1885. In 1867 (as a captain) he was attached to the British Commission at the International Universal Exhibition, at Paris, where he superintended the erection of all the buildings undertaken by the commission, and was in charge of the experiments on heating and lighting carried on in the English test house. In 1870 he was placed in command of the 22d and 34th companies of Royal Engineers for service in the Postal Telegraph Department, and was instrumental in training in all branches of telegraphy over 300 officers, non-commissioned officers and soldiers of the Royal Engineers, whose services have since been of value in several military operations. In 1870 and 1871 he and Colonel Bolton originated and founded the Society of Telegraph Engineers, of which he has since been either the treasurer or a member of council, and in 1882 he was elected the president of the year. In 1878 (when a major) he was appointed by H. R. H. the Prince of Wales British juror for telegraph apparatus at the International Exhibition at Paris. In 1881 he was appointed by Her Majesty's government one of the British Commissioners for the Electrical Exhibition at Paris, and was also one of the members of the International Electric Congress held the same year in Paris. He was a member of the General Council, and of the Jury for the Electrical Exhibition at the Crystal Palace in 1882, and was a member of the Electrical Jury at the Health Exhibition in 1884. Major-General Webber was charged with experiments in connection with prizes, offered by the Society of Arts, in 1872, for inventions in apparatus for heating and the utilization of fuel, and has thrice sat as a member of council of that society. He is the author of several papers in the "Journal" of the Society of Telegraph Engineers and Electricians, and on many military subjects. He is a member of the Institution of Civil Engineers, and a member of council of the Royal Albert Hall Corporation. He was first managing engineer and director, and afterward consulting electrical adviser, of the Anglo-American Brush Electric Light Corporations from November, 1885, to July, 1889; is deputy chairman and consulting engineer of the Chelsea Electricity Supply Company (Limited); was chief engineer of the City of London Electric Lighting Company, and is an original Member of the Société Internationale des Electriciens.



Inductive Circuits.

The Lond. "Electrician," of July 28, contains an article of Dr. Sumpner, in which he takes the simple equation for the alternating current in a circuit containing a coil and condenser in series, and shows how the curves representing these relations may be drawn graphically in a simple manner; three sets of curves are given, the ordinates of all of which are volts or ampères (there being a double set of curves in each diagram), the abscissas are in one case self-induction, in the other capacity, and in the third frequency, the remaining factors in each case being considered constant; the object is to show how the factors vary with different relative values of the inductance, capacity, resistance, etc., of the various parts of the circuit. Although much has been written concerning the action of combinations of coils and condensers, he states that the values chosen have, as a rule, been such as would apply only in very exceptional circumstances, and the assumption has been made that the curves representing these special cases give a correct idea of the effects which actually occur; in the present paper, therefore, a series of curves is given showing how the curves change with different values of each of the quantities in the formulæ. The paper is not of a nature to admit of being abstracted; it is recommended to those interested in the subject; it is clear and concise, and not burdened with abstruse mathematics.

Mechanical Generation of Current.

According to the "Elektrotechnische Rundschau," No. 19, Prof. Braun has discovered that if a spiral of wire be elongated mechanically a current will be produced in it; the current will be in the opposite direction in a left-handed spiral than in a right-handed one; it is said that he has satisfied himself that it is not due to magnetic or thermo-electric effects, but is based on the fact that the bending of a wire generates a current in it; he found that nickel was the best metal to use; the reverse of this experiment is also claimed to be true, a current passing through a spiral in one direction causing it to elongate, while if passed in the other direction it will cause it to contract. A current passed through a spiral will, however, produce magnetic effects which cause the spiral to contract for either direction of the current, an experiment well known to physicists, which is explained by the fact that parallel currents attract each other; if, therefore, there is an elongation in Prof. Braun's second experiment the effect must be greater than that in the opposite direction due to the attraction of the currents in the convolutions; his conclusions, therefore, would seem to require further proof before they can be accepted.

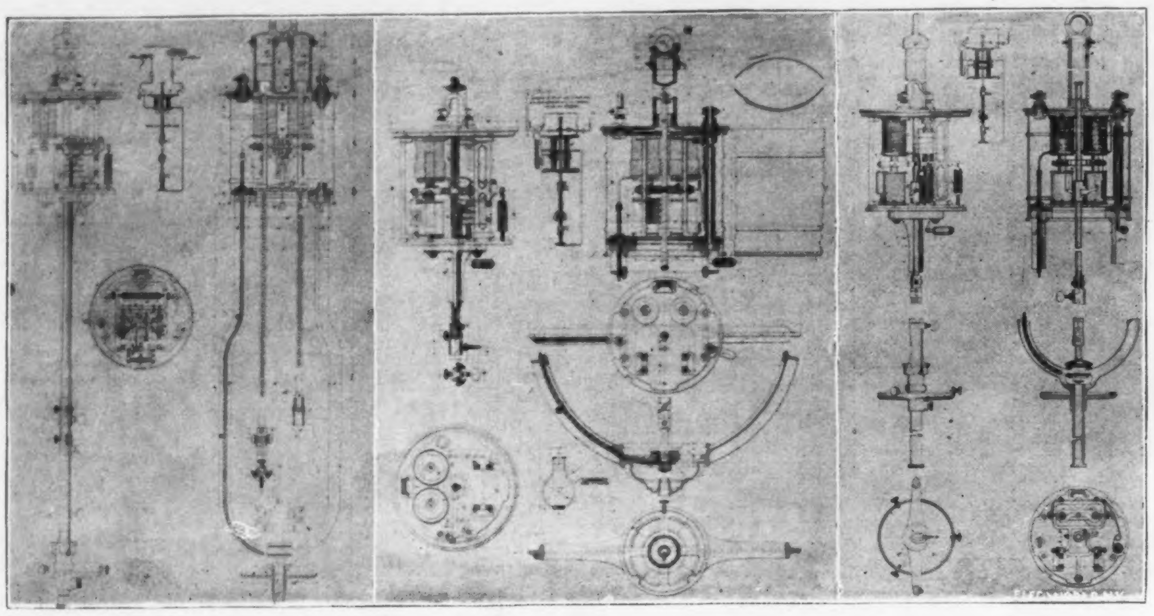
Mechanical Analysis of Alternating Current Curves.

"L'Electrcien" of June 24 states that an instrument devised by Messrs. Sharp & Henrici, recently exhibited at the Royal Society, will analyze the curve of an alternating current and decompose it into the sine curves, according to the series of Fournier, by tracing the curve with a style, the apparatus draws the sine curves representing the first five terms of the Fourier series; a second operation gives the next five terms.

Arc Lamps at the World's Fair.—1.

DIFFERENT TYPES OF WOOD ARC LAMPS.

Alternating Current Arc Lamp.—This lamp is essentially a gravity feed lamp, regulation being effected by means of a solenoid, a U-shaped laminated core being used. This core slips into two coils of copper wire, through which the whole current of 10 amperes passes. As the current in these coils weakens, through the arc lengthening out, the U-shaped magnet retires from the coils, and vice versa. This magnet is connected to the main frame of the gear carrier, which is pivoted about the centre to two uprights and serves two purposes: 1st, as a medium for securing the rocker, and 2d, to give the body of the lamp great rigidity. A train of wheels, the last one of which at one



FIGS. 1, 2 AND 3.—WOOD ARC LAMPS.

end meshes with the carbon rod, while the other gear at the other extreme end engages with a detent spring, which, unless the lamp is at the proper point of feeding, retains the gears and prevents any motion in the carbon rod. In the double lamp an automatic cut-over is arranged on the main spindle, whereby the burnt-out carbon rod is disengaged and the second rod brought into service. A glance at the cut, Fig. 1, will enable any one to trace out the connections of the lamp, and general arrangement of rheostat hanger-board and fuseblock combined.

The standard single and double gear feed Wood arc lamp has an H-shaped core, two legs of which enter the main coils on the top, and the other two the shunts situated on the bottom of the lamp. The feed and escapement in this lamp are identical with the alternating lamp. This lamp is fitted with a relighter, two absolute cut-outs, one hand and one automatic, and when the carbons are entirely consumed another automatic cut-out short-circuits the lamp, cutting out the coils entirely.

Like all other lamps of Mr. Wood's design, this one is made absolutely interchangeable, and either kind of frame—straight or bow—can be fitted at will. The single lamp is shown in Fig. 2.

Perhaps the simplest lamp of the lot is the new clutch lamp, made in single and double forms, of which the first is shown in Fig. 3. This lamp has also an H-shaped core connected with the main rocker. The mains and shunt coils are placed in relatively the same position as in the gear-feed lamp. When the current is established, the main coils pull up the H-shaped core and the rocker attached to it, the clutches, being connected to this rocker, raise the rod and strike the arc. As the arc lengthens out, the whole arrangement lowers, until one arm of the clutch trips on the regular tripping piece and allows the rod to fall, so adjusting the arc without any alteration of the light. This lamp, like the gear-feed, is fitted with a relighter, automatic and absolute cut-outs, and can be fitted with either straight bow frame or short frame for low ceilings. Accompanying this are found diagrams showing the different connections of the lamp in detail, so that no trouble ought to be experienced in tracing out the different uses and actions of the various parts employed.

All of these lamps are manufactured by the Fort Wayne Electric Company, and may be seen in their exhibit.

GENERAL INCANDESCENT ARC LIGHT COMPANY.

The arc lamps exhibited by the General Incandescent Arc Light Company, of New York, operate successfully on continuous current circuits, as well as alternating, railway and high-tension circuits, and are made in the following styles: Standard lamps, ornamental lamps, chain and bijou lamps. The feed mechanism of these lamps is practically the same in all. The rack feed is adopted, with the exception of the bijou and chain lamps, in which the upper carbon holder is attached to a chain wound upon a drum. For continuous current circuits the mechanism has but one electromagnet, the winding of which is always the same for all candle power, the resistance of the shunt coil being 440 ohms. The feeding arrangement is regulated by means of a tension spring and controlled by the electromagnet, so that the carbon feeds at a rate equal to its combustion.

The voltage at the arc for the different candle powers is as follows:

4 ampères	=	41 volts.
6 "	=	42 "
8 "	=	43 "
10 "	=	44 "

If, for instance, two lamps are run in series across 115-volt constant potential circuit and adjusted to consume eight ampères, the voltage between the arcs being 43, there would be required nearly 4 ohms dead resistance to make up the difference in potential. Each lamp is provided with its own resistance, so that two ohms German silver wire are placed in the chimney of each of the two lamps. Five of these lamps operate successfully across a 230-volt circuit.

For railway or 500-volt circuits ten lamps are connected in series, with an external resistance. These lamps are supplied with an additional shunt coil which automatically cuts in resistance to take up the pressure of that lamp in case it should possibly get out of order, and does not interfere with the working of the others. All lamps for continuous current are devoid of dash-pots or series coils, and have an automatic arrangement whereby when the carbons are consumed to the proper length they automatically cut themselves out, thus preventing the burning of carbon holders.

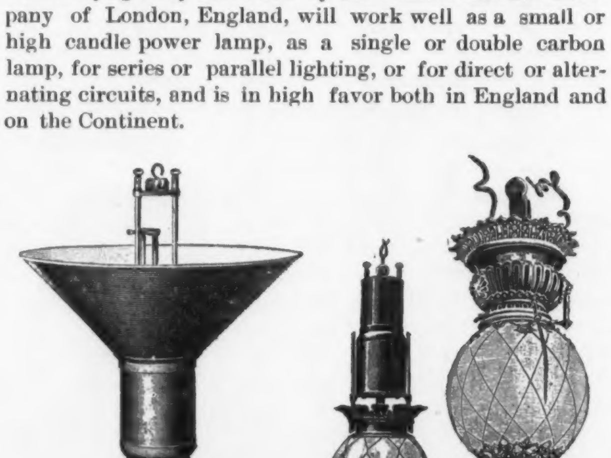
The bijou lamps are intended for constant potential circuits, and are the smallest arc lamps manufactured, the entire length being but 30 inches; it is therefore particularly adapted for ornamental fixtures.

For alternating currents the lamps are manufactured in two styles, called series coil and shunt coil lamps. In the first, one lamp will burn across a 30-volt circuit without resistance. In the second, for a 50-volt circuit one lamp can be operated with an additional resistance coil, and across a 100-volt alternating circuit three lamps can be run in series with one additional resistance.

All lamps are tested and adjusted to the given ampères and volts, and in all cases the lamp frame is thoroughly insulated from the current carrying parts, and in general has the following advantages: Small size and weight; cheapest lamp to trim; all corresponding parts absolutely alike; large range of candle power; length of life; burns steadily and noiselessly, giving a soft and beautiful light.

BYNG ARC LAMPS.

The Byng lamp exhibited by the General Electric Company of London, England, will work well as a small or high candle power lamp, as a single or double carbon lamp, for series or parallel lighting, or for direct or alternating circuits, and is in high favor both in England and on the Continent.



BYNG ARC LAMPS.

Electrically speaking it is a differential lamp, direct acting on the carbon holders, without any clockwork, springs or other mechanism. All the working parts are carried on one plate suspended over a pulley and passing along rollers. There is an electromagnet between the tubes and an iron core inside the tubes, which will short-circuit the magnetic field. The core of the lower carbon holder tube is wound with fine wire and is in series with the fine wire turn of the electromagnet, and the other core is wound with thick wire in series with the thick wire turn of the electromagnet. When no current passes through the lamp, the two carbon holders and the carbons are equally balanced.

When the lamp is put in circuit the first action of the current is to separate the two carbon points, thus cutting out the thick wire magnet, and the fine wire coil is left to act alone. This action causes the coil to attract the bottom carbon holder until the carbons touch again. At that moment the main current passes and the action of the shunt ceases. The series coil is, therefore, the only one acting, and this raises the top carbon, and the main current is reduced by the resistance caused by the arc, and again the difference of potential causes the current to go through the shunt coil.

The two windings of the electromagnet are in the opposite directions, and tend to neutralize each other, and the magnetic action only takes place when the one or the other is predominant. If neither predominates the carbon holders remain balanced in the same position. On the slightest alteration in the length of the arc or the ampères of the main current the equilibrium is disturbed sufficiently to start the differential action again. In order to prevent violent jumping of the light at the formation of the arc there is attached to the pulley a brake, to which the above mentioned tubes are suspended, and which only allows the tubes to travel up and down within a very limited space until the lamp has regulated itself.

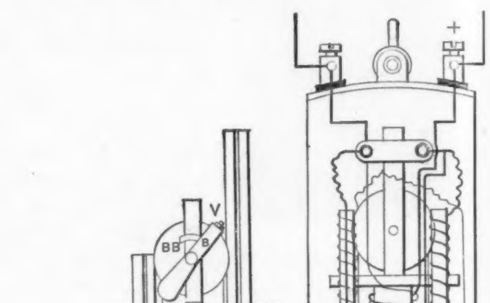
The same lamps with suitable holders can be used for burning two carbons, and burn quite satisfactorily. The lamp itself is covered with a waterproof cover, and the internal parts are nickeled or lacquered to prevent oxidation.

The working of this extremely simple lamp will be readily understood from the following diagrams:

The object of the brake is to prevent the carbon points from separating too much when the arc is first struck, and by tightening or loosening the screw **V** in the diagram below, the *proper* length of the arc can be adjusted. When the current is on the screw **V** must not by any means touch the carbon holders. Referring to the cut:

B is the brake,

B B, a brake wheel over which carbon holders are slung,



MECHANISM OF BYNG ARC LAMPS.

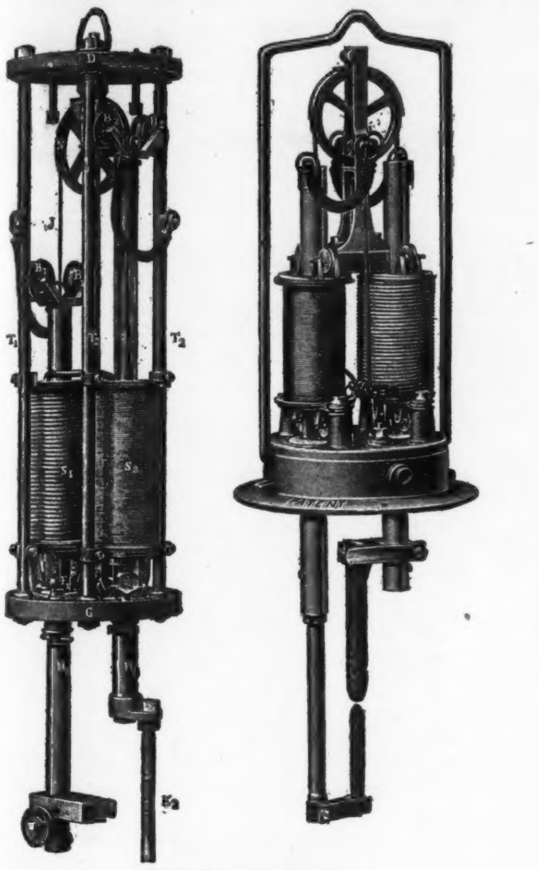
C C are carbon holders which rise and fall as carbon is consumed, and

SS is a cord by which holders are suspended.

One of the great disadvantages of arc lighting for indoor use, especially for mills, factories, etc., is the intense shadow which the light throws on the floor and benches. This in a factory where belting, shafting, etc., are fitted up, and where the work to be done is of a delicate nature, has rendered the use of the arc lamp practically impossible. This company have succeeded in producing a system of indirect illumination which overcomes these obstacles. Their Byng lamp, of the reversed type, is practically the same in construction as that previously described, with the exception that it is fitted upside down inside an enameled reflector, which throws the light up to the ceiling. Provided the ceiling is white and the lamps fitted at the proper height and angle to each other, the ceiling reflects the light down absolutely shadowless onto the floor or benches.

THE PILSEN ARC LAMP.

The extremely simple mechanism of the Pilsen arc lamps manufactured by Schuckert & Co. shows a great advance in the manufacture of the carbons, as the light shines perfectly quiet and uniform, and has neither wheel work nor attachment, nor spring contrivances. The whole work, which, in beginning to act, produces the arc and keeps it at normal length during the burning, consists principally of two coils of copper wire, of a cord with pulley running over a wheel, of two iron cores, and the carbon holder. One coil, the so-called main coil, S1, has a few thick wire spirals in series to the arc, the other one, the so-called shunt coil, has many fine wire spirals and is in shunt to the arc. The two iron cores are movable in the direction of the axis of the coils, consist of soft iron and have the shape of a cone (see Fig. E_1, E_2). The carbon holders H_1, H_2, are mechanically connected with those cores. The two coils are fastened next each other, each to a pair of transverses, T_1, T_1, and T_2, T_2. These transverses form a rigid connection between the bedplate G and the cover plate D, but are insulated from both plates. The carbon holders H_1 and H_2 are hollow brass tubes which surround



THE PILSEN LAMP.

the conical iron core, are hanging on a common silk cord, and are led over the channeled pulley N. In consequence of this hanging position both carbons always move in equal distances—the positive carbon K_1 downward, the negative one K_2 upward, or vice versa. Each carbon holder has a double guide; the one between the bedplate and the coil consists each of three pulleys, F_1 or F_2 which, movable on a fixed axis, run on the periphery of the carbon holders; the other one, above the coil, consists of a transverse fastened to the carbon holder each with two channeled pulleys, B_1 and B_2, whose channels run on the transverses T_1, T_1, or T_2, T_2. Both iron cores E_1, E_2, are pulled upward by the coils during the passage of the current; these attractions work so in opposite directions, the main coil S_1 tending to produce a separation, the shunt coil S_2 an approach of the carbon points. According, then, as the current (in case of being too small) or the voltage (in case of the one being too large) is predominant, an approach takes place as long as the length of the arc is normal, an equilibrium is obtained.

With the consumption of the carbons the relative position of the coil and its iron core is altered, the core E_2 being pulled by degrees into the shunt coil, whereas E_1 gradually leaves the main coil. For these changes of relative position not to affect the arc, the attractive power between the core and coil must be independent of the relative position, and this is obtained by the peculiar conical shape of the iron cores. The cross section of the lower negative carbon is only about half as large as that of the upper positive carbon, for the arc light consumes only half as much of the negative carbon as it does of the positive one, so that both carbons are equally consumed, and on account of the continued uniform propulsion the arc light is always produced at the same place. As another consequence of the small diameter of the negative carbon, only a slight portion of the cone of light which the crater of the positive carbon throws downward is covered in the middle, and this has the result of the whole utilization of the produced quantity of light. Both binding posts, as well as the whole current-paths in the lamp, are well insulated from the proper body of the lamp, so that there is no loss of current to the ground. If a series of lamps are placed in the same circuit, the current in the whole circuit must always be constant, in order of every lamp, independent of the other, being able to produce its normal amount of light. For this purpose those lamps are furnished with a compensating resistance which, when the lamps are cut out (after they have burned to a certain length), is connected with the circuit in the arc and permits the passage of the same quantity of current. The automatical cut-out of the main current from the resistance on the arc light, and vice versa is effected by the electromagnet W with a contact screw and a movable armature.

On the other hand, in case of parallel working, the arc lamps are connected in as many circuits of derivation, and these can be cut out or switched in independent of each other. The lamp as shown for parallel circuit is therefore furnished with a compensation existence. As soon as the carbons of the lamp are consumed to a certain distance, the transverse of the negative carbon holder meets the cover plate; a further approach of the carbon points is thus prevented, and the arc immediately extinguishes. If two and two of those lamps are connected in series in the same circuit, the single pairs are independent of each other; on the other side, if the pair of lamps are lit and burn simultaneously, as soon as the one lamp extinguishes, or the carbon is burned down, the other lamp extinguishes too. The double supply of carbon holders, as described above, prevents both the twisting of the two carbon holders as their mutual replacement when the lamp takes an inclined position; as further no weight is used in the regulating mechanism, the lamps burn in every position and are not influenced by any kind of motion. These two kinds of lamps are therefore pre-eminently suited for open-air and railway station plants, where the lamps are exposed to the wind and also for ships and carriages which are exposed to much concussion. A third kind of lamp, to be placed in multiple arc, is for lighting localities which are protected from the wind and concussion. This lamp has a more simple light regulator, but it is, nevertheless, built on the same system as the two described above.

These lamps are supplied in different finish for open or covered spaces, according to the functions required of them.

By the perfect facilities for its manufacture, and principally by the introduction of special tools, the cost of production has considerably been reduced, so that the price of the lamps at present is much lower than it formerly was.

The lamp has therefore, besides the advantage of excellent construction and finishing, which assure the most perfect continual regulation, the further preference of a low price.

THE SIEMENS-HALSKE ARC LAMPS.

Band Arc Lamp.—This lamp is patented in the United States, patent No. 412,141, and manufactured in the following sizes:

1. For continuous current.

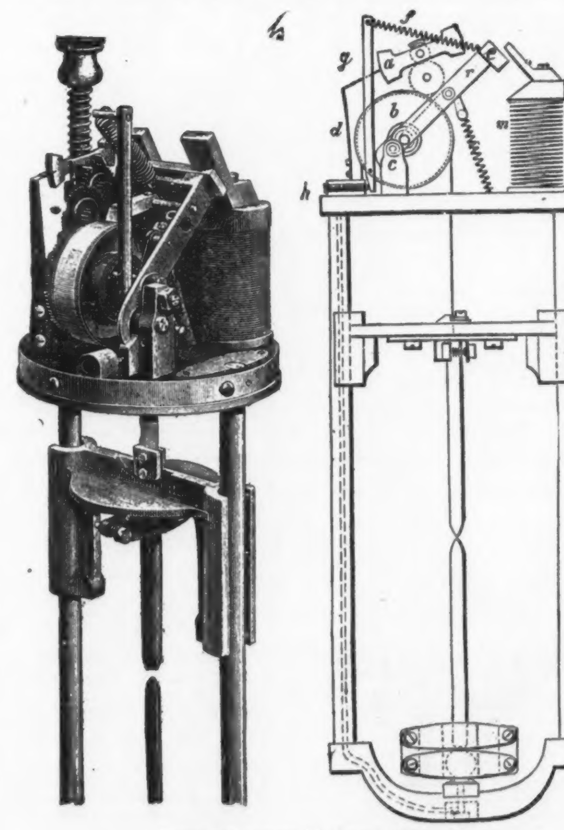
a. Smallest size band arc lamp, for currents from 1 to 3 amperes. b. Medium size band arc lamp, for currents from 3 to 9 amperes. c. Largest size band arc lamps, for currents from 10 to 35 amperes

2. For alternating current. a. Smallest size band arc lamp, for currents from 1.5 to 4.5 amperes. b. Medium size band arc lamp, for currents of 3 to 16 amperes. c. Largest size band arc lamps, for currents of 17 to 35 amperes.

The smallest size lamps are made in one length only, and will receive carbons with a maximum length of both equal to 15¾ inches.

The medium and largest lamps are made in three different lengths; i. e., for carbons 15¾ (10 hours), 19¾ (14 hours), and 25½ inches (18 hours), total length.

The medium and largest size of both direct and alternate current lamps are also made as focusing lamps.



THE SIEMENS HALSKE LAMP.

The construction of the band arc lamp is based on the following principle: An inclined frame turns on pins c and supports a drum b, around which a copper band is wound. This frame also supports the pinion wheels with the escapement, and at the upper end of the frame a crosspiece e, which is the iron armature. The attraction of a shunt electromagnet m, and the weight of the upper carbon and holder, draw the frame r downward, while a spring f pulls in the opposite direction. The unwinding of the copper band causes the drum b and the pinion wheels to revolve, while the escapement with its balance lever a oscillates rapidly. When the frame r is in its highest position, a tongue piece projecting from the balance lever a strikes a stop g, and the motion of the clockwork ceases. By turning the frame downward, the copper band, which carries the upper carbon holder, is gradually unwound from the drum, while the upper carbon holder sinks slowly by its gravity.

The lamp operates as follows: When the current is turned on, the frame is turned downward by the strong attraction of the shunt electromagnet into its lowest position, and the copper band unwound until the upper carbon touches the lower one. The current will then flow through the carbons instead of through the shunt, and the electromagnet therefore loses its currents. The spring, having an excess of power, draws the frame up again and forms the arc between the carbons. If the carbons are consumed the current in the shunt magnet is increased gradually and the frame is drawn downward again and the arc is brought to its proper distance. The slightest change in the length of the arc will start the escapement, and this will cause the lamp to feed in regular intervals of time. The light is therefore very constant and the arc is practically constant.

Thomson-Houston Differential Lamp.—This lamp, constructed by Herr von Hefner-Alteneck, was the first lamp which solved the problem of connecting several lamps in one circuit. The regulating mechanism consists of two bobbins, one with thick wire, the other one with thin wire, which work on an iron armature. If the attracting force of either the upper or lower bobbin is larger, the iron armature is drawn upward or downward, respectively. The iron armature is by a leverwork connected with the clockwork, which is kept going by the weight of a rack, which carries the upper carbon. By switching in the lamp the thick wire bobbin is strongly excited, draws the armature downward, by which movement the upper carbon is moved upward and the arc is formed. If the carbons are consumed more current flows through the thin wire bobbin, the armature is drawn upward and the upper carbon holder therefore shifted downward. This lamp is very sensitive in regulating the arc. It may be used for parallel circuit as well as for series circuits. In the latter case the lamp is provided with a short circuit contact, so as not to interrupt the current when one lamp is extinguished. The differential lamp is also built as a focusing lamp.

The sizes are:

Differential lamp No. 3,300, 400 millimetres; length of carbons, 6 to 25 amperes, alternating current and 8 hours burning; 3 to 25 amperes direct current and 8 hours burning; 3 to 25 amperes direct current and with 10 hours burning.

Differential lamp 3,300, for 13 hours burning and 700 millimetres, total length of carbons, for currents of 5 to 25 ampere alternating current.

Long differential lamp No. 3,300 for 580 millimetres, total length of carbons, for 6 to 35 amperes alternating current and 10½ hours burning, or 3 to 35 amperes direct current and 16 hours burning.

LAMPS FOR SEARCH LIGHTS.

These lamps are manufactured in different constructions, as to be well adapted for different special purposes. There are lamps for hand regulation, and self-acting lamps.

a. Contact lamp No. 2,301, for direct current up to 20 amperes.

b. Contact lamp No. 5,073, for direct current up to 40 amperes.

The lamps are made for regulating either in vertical or in horizontal position.

Self-acting horizontal lamp No. 5,075 and 68, used for currents up to 150 amperes. These lamps are also made with hand regulation and as iron-clad lamp, for use on board of men-of-war.

Self-acting horizontal lamp (lever lamp). This lamp has no clockwork and regulates on constant strength of current.

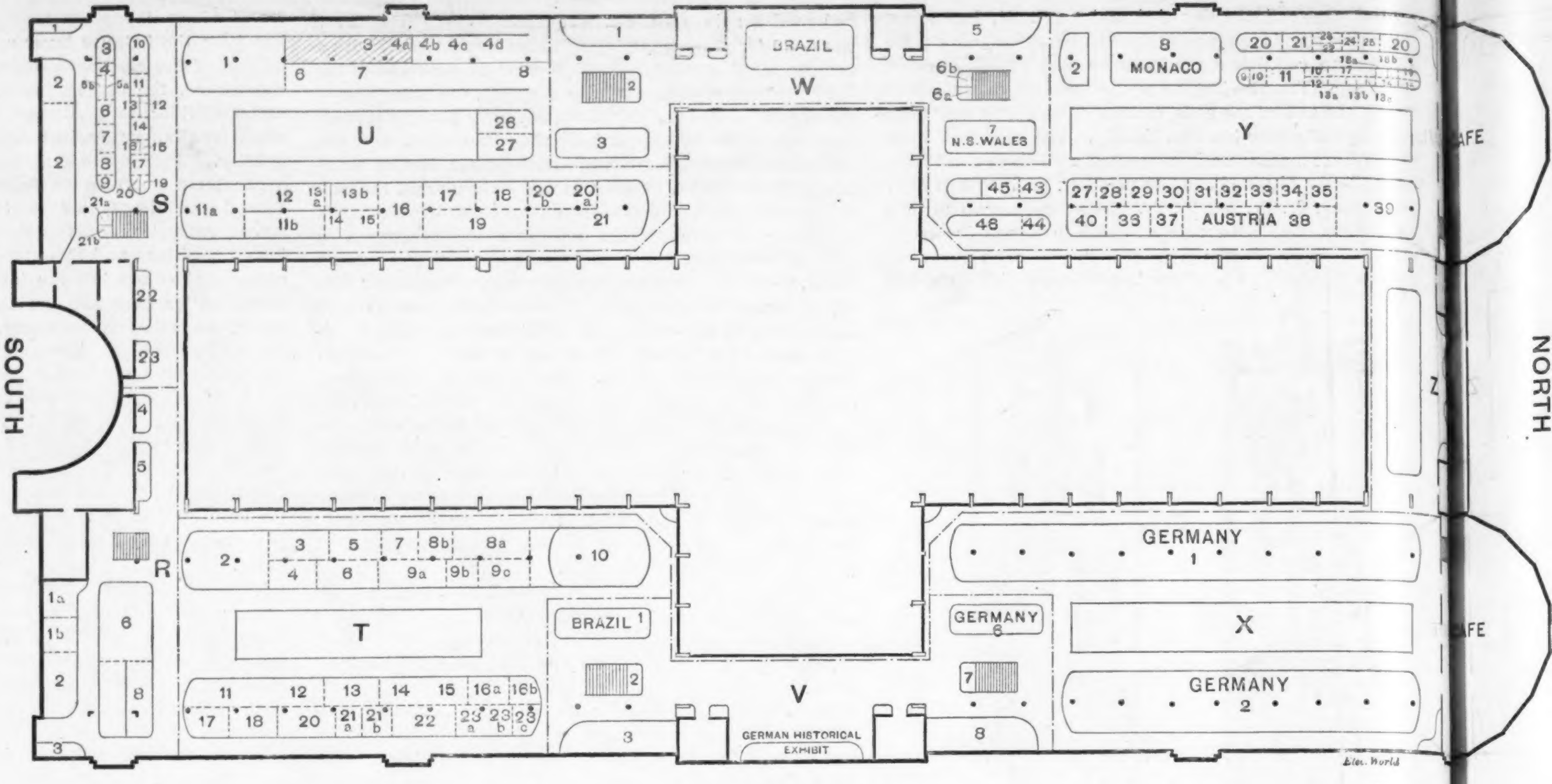
Self-acting lamp with inclined carbons, No. 5,065. Lamps for hand regulating Nos. 4,326, 5,074, 2,306. Search lights with either metal or glass parabolic reflectors or meniscus ring mirrors are manufactured for any desired amperage.

Current Distribution in Networks of Conductors.

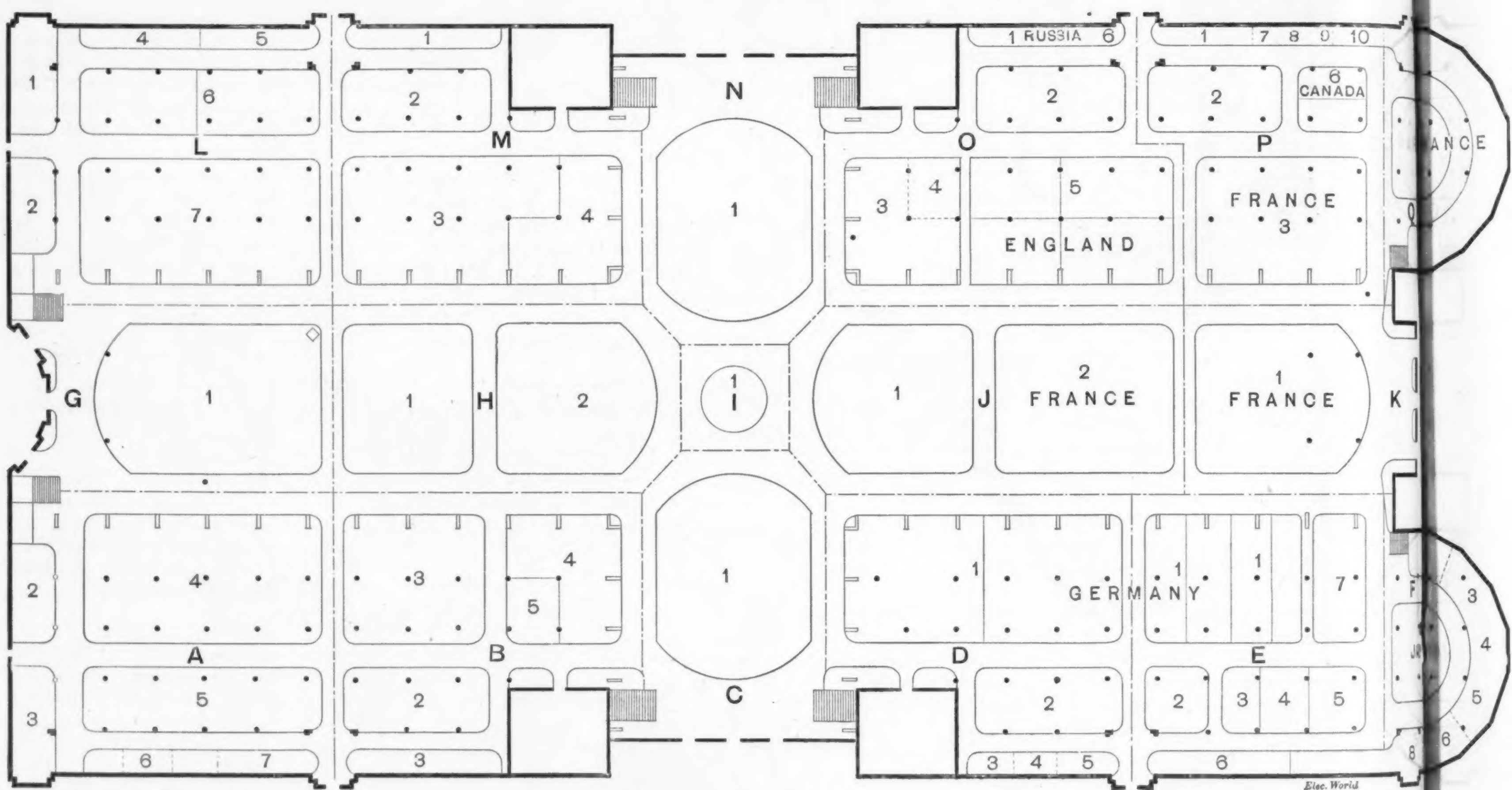
Mr. Coltri, in the "Elek. Zeit.," July 28, gives briefly the theory of a method for determining the current and voltage in complicated networks of mains, in which all the conductors of the same polarity are connected together at their ends forming closed systems, as distinguished from lines having dead ends. He shows that (a) the differences between the voltages at the various junctions for no load and for a load at one junction are directly proportional to that load; and (b) when a change of load at two or more junctions produces a difference in the voltages at the other junctions of the network; this difference is equal to the sum (the algebraic sum is probably meant) of the differences which would be caused if the loads were applied separately. By means of these laws he states that the voltages and the distribution of the current may be determined for all loads in such a network of conductors.

ALPHABETICAL INDEX.

ELECTRICITY BUILDING.



GALLERY

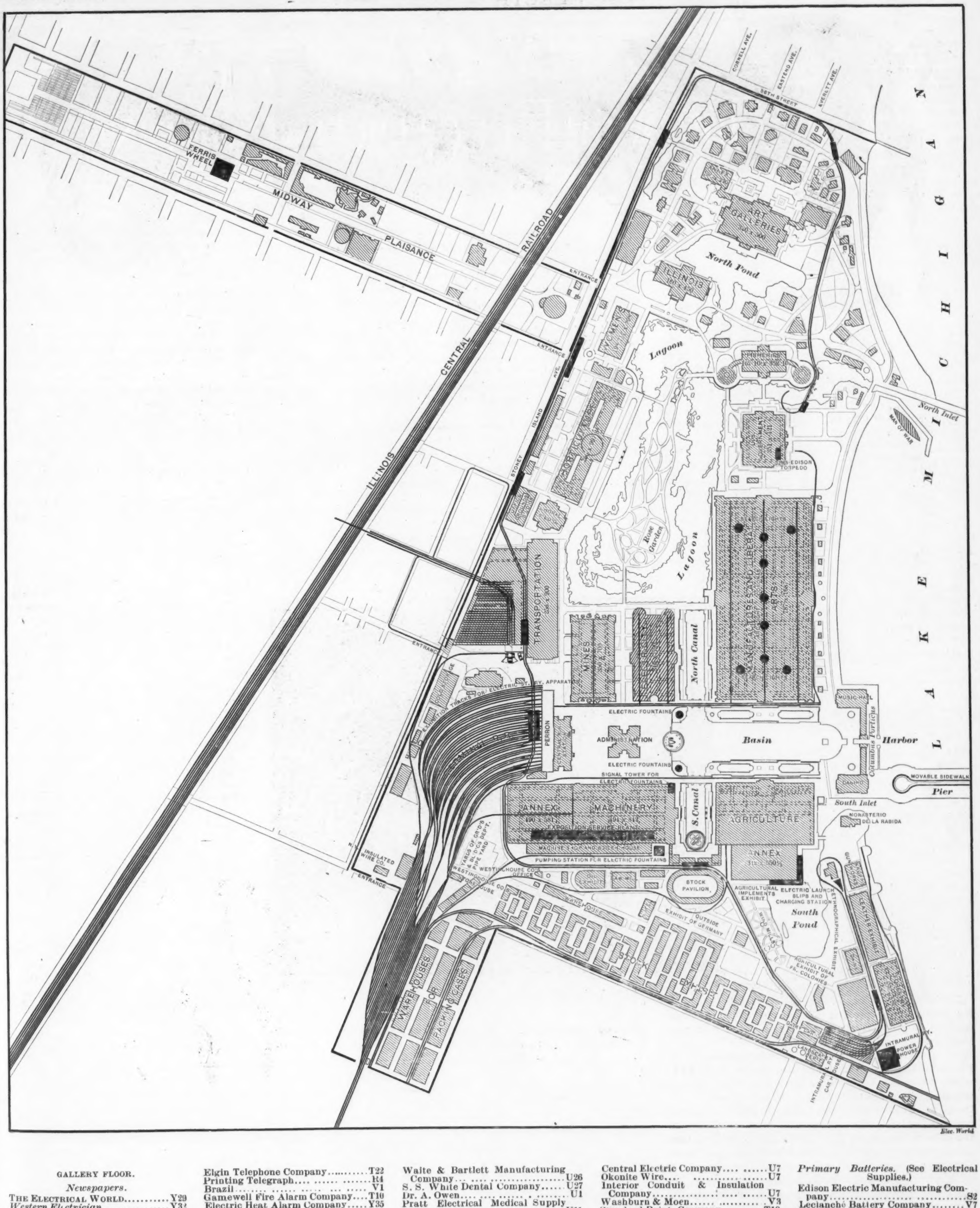


GROUND FLOOR

CLASSIFIED INDEX.

GROUND FLOOR.

GUIDE TO THE ELECTRICAL FEATUR



GALLERY FLOOR.

Newspapers.

THE ELECTRICAL WORLD............Y29
Western Electrician............Y32
Electrical Engineer............Y30
Electrical Review............Y33
Electrical Industries............Y27
Electricity............Y31
Street Railway Journal............Y28

Telegraph, Telephones and Signals.

Commercial Cable Company............Y2
Gray's Telautograph............W5
N. S. Holmes............W1
Western Union Telegraph Company............V8
Imperial German Postal and Telegraph Department............X1
Electric Selector & Signal Company............U19
Tate Automatic Electric Signal Company............Y37
Strowger Automatic Telephone Exchange............T8
Elgin Telephone Company............T22
Printing Telegraph............R4
Brazil............V1
Gamewell Fire Alarm Company............T10
Electric Heat Alarm Company............Y35

Lightning Rods.

N. C. Gault & Company............Y40
Buckley & Knapp............S10

Iron Towers.

Star Iron Tower Company............W4
Hope Electric Appliance Company.S17

Electric Clocks.

Newman Clock Company............Y39
Eco Magneto Clock Company......Y38
Dulaney Clock Company............R5

Electro Medical and Dental Appliances.

H. A. Lawton............Y45
Pulvermacher Belt Company......Y46
J. C. Vitter & Company............W2
McIntosh Battery & Optical Company............W3
Waite & Bartlett Manufacturing Company............U26
S. S. White Dental Company......U27
Dr. A. Owen............U1
Pratt Electrical Medical Supply Company............U11
Dr. G. Meeker............S7
Dr. G. F. Webb............Y44
Germany............Y38 X1

Stamps.

Bates Manufacturing Company....Y43

Cloth Cutting Machinery.

Caldwell Electric Cloth Cutting Machine Company............V36

Insulation.

Roessler & Hasslacher Chemical Company............S9
India Rubber Comb Company and the Goodyear Hard Rubber Company............S11
O. K. Weatherproof Wires........U10
Enterprise Electric Company......U11
Central Electric Company..........U7
Okonite Wire............U7
Interior Conduit & Insulation Company............U7
Washburn & Moen............V3
Standard Paint Company..........T18
New York Insulated Wire Company............T11
Chicago Electric Wire Company .T16
Norwich Insulated Wire Company............T16
H. W. Johns Manufacturing Company............U21
Simplex Electrical Company.......T3
Kerite............T2
W. R. Brixey............T2
New England Butt Company......T13

Electro-deposition.

Chas F. Hall............U1
F. A. Ringler............R1a

Storage Batteries.

Pumpelly & Sorley............T4
Consolidated Electric Storage Company............R2

Primary Batteries. (See Electrical Supplies.)

Edison Electric Manufacturing Company............S2
Leclanché Battery Company.........V7
The Hanson Primary Battery Company............T21
Herlemann Battery Company.......S3

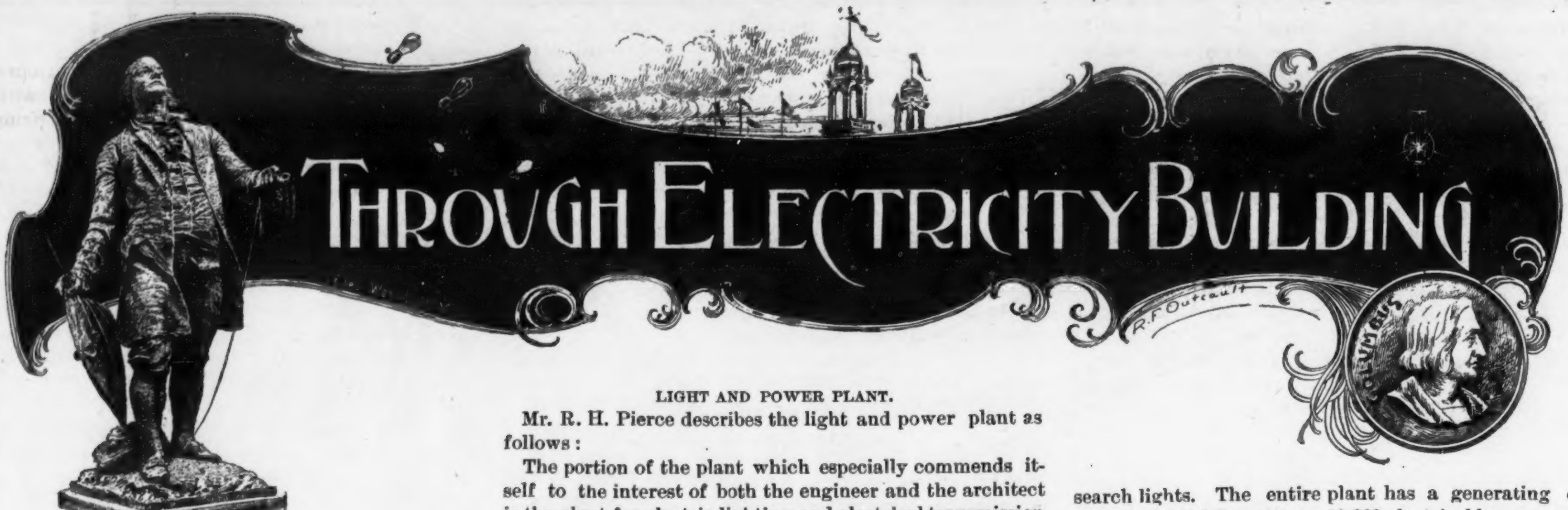
Miscellaneous.

American Institute Electrical Engineers............South End
Headquarters Jury of Awards South End
Department of Electricity..South End
Electric Launch & Navigation Company............R1
Splicing Carbons............R8
Phonograph Display............S2
Electrical Boot Blacking Machine..T16
The Warth Electrical Torpedo Gun.T15
Recording Meters............U13

Carbon.

Washington Carbon Company......U
National Carbon Company........T1

FEATURES OF THE WORLD'S FAIR.



AN ELECTRICAL GUIDE TO THE WORLD'S FAIR.

We will suppose a party coming to the World's Fair Grounds by the lake route and landing at the pier, and that a glance will first be taken of the various electrical features of the World's Fair, outside of Electricity Building.

The entire electrical equipment of the Pier Movable Sidewalk Company has been done by the General Electric Company. The buoy line from the city to the pier is supplied with T.-H. series lamps and run from Fort Wayne arc machines. Passing through the annex of Agricultural or the Shoe and Leather Building there will be found a great many applications of stationary motors used for running machines direct and from counter-shafting with and without load. The entire motor system of the World's Fair, including all motors from 1 to 135 h. p., has been furnished by the General Electric Company. This includes not only the motors now in service performing the various functions in and about the Exposition, but also all the motors that have been used for the hoisting of material into place on the various buildings, for the running of saw mills, planers, sewerage and water pumps, pipe cutting and pipe threading machines, painting machines, etc., etc.

Following the Intramural Railway, which has been put up and equipped complete by the General Electric Company, we come to the power house and the car barn of the railroad at the southeast corner of the grounds. The power house is always open to the inspection of the public and will be found of exceeding interest. It contains the following machinery:

Five hundred kilowatt four-pole dynamo, belted to a tandem compound Providence Steam Engine Company's 900-h. p. engine.

Two hundred and fifty kilowatt six-pole generator directly connected to a 400-h. p. tandem compound McIntosh & Seymour engine.

Four hundred kilowatt twelve-pole dynamo directly on the shaft of a 750-h p. tandem compound E. P. Allis engine.

Seven hundred and fifty kilowatt generator directly on the shaft of a 1,250-h. p. cross compound vertical Lake Erie Engineering Works' engine, Williams design.

One thousand five hundred kilowatt dynamo directly on the shaft of 2,000-h. p. cross-compound E. P. Allis engine.

The latter is the largest dynamo ever built for power service, proving so heavy that it had to be constructed in place in the power house of the Intramural Railway, the parts being shipped from the factories at Lynn and Schenectady and from engine works at Milwaukee and assembled on its foundations in the power house, where it now stands, by special workmen sent out for that purpose. The rotating parts weigh 190 tons, and the inertia of the same when speeded up to 75 revolutions, its normal speed, is sufficient to carry one of the Intramural trains from the gates at the World's Fair to the Van Buren street station of the Illinois Central Railroad.

Adjoining the annex of Agricultural Building is the charging station of the Electric Launch and Navigation Company, the corporation furnishing launches for the electric launch service at the World's Fair. This charging station is put in and maintained by the General Electric Company, and is one of the largest storage battery stations in constant use in the world. The charging station is always open to the inspection of engineers. To supply the current for the same four 150-kw. Edison bi-polar generators, used earlier in the evening for supplying the electric fountains, are diverted at 11 p. m. to this station and continued in this service until 7 o'clock the following morning. The motors in these launches are also supplied by the General Electric Company and counterparts of the same can be seen in the exhibit in the Electricity Building. The motive power is supplied by storage batteries, which for the ordinary speed are grouped in three divisions of 26 cells in series, giving a voltage of 52 and a discharge of 42 to 45 ampères.

LIGHT AND POWER PLANT.

Mr. R. H. Pierce describes the light and power plant as follows:

The portion of the plant which especially commends itself to the interest of both the engineer and the architect is the plant for electric lighting and electrical transmission of power.

All the electrical machinery for furnishing light and power is located in Machinery Hall, so that the power plant in Machinery Hall is a great central station. I say "central station," but, in fact, the plant is divided, as far as operation is concerned, into nine distinct central stations, each of which, under normal working conditions, is entirely independent.

The plant comprises 98 direct current series arc dynamos, having a total capacity of 5,230 lamps of 2,000 nominal candle power each, 14 alternating current incandescent dynamos having a total capacity of 128,000 lamps of 16 c. p., one direct current incandescent dynamo having a total capacity of 800 kilowatts and 20 direct current power generators, having a combined capacity of 2,936 kilowatts, or 3,935 electrical horse power. In addition to these, there are also four direct current generators, having a total capacity of 600 kilowatts or 804 electrical horse power, which serve the double purpose of supplying current to operate the electric fountains and to charge the storage batteries for the electric launches. There is also one direct current generator of 700 kilowatts or 938 electrical horse power, which operates both arc and incandescent lamps; and, finally, one direct current generator of 180 kilowatts, and one of 45 kilowatts, a total of 225 kilowatts, or 300 electric horse power, which supply the current for search lights. The entire plant has a generating capacity of 14,916 kilowatts, or 19,989 electrical horse power, so that it would require not less than 25,000 indicated horse power to operate all the dynamos to their full working load.


ELECTRICITY BUILDING FROM THE LAGOON.

For the purpose of description, we will divide all the dynamo-electric machines into two classes. First, Exposition dynamos, or machines furnishing service to the Exposition and operated by the electrical engineering department; secondly, exhibit dynamos, or machines furnishing current to exhibitors in Electricity Building and operated by the various electrical companies which furnish them as exhibits

The arc light plant comprises the following machines:

Western Electric plant:	10 Exposition dynamos,	50 lts. each, total, 500 lights
	2 Exhibit "	50 lts. each, total, 100 lights
Thomson-Houston plant:	27 Exposition dynamos.	50 lts. each, total, 1,350 lights
Excelsior plant:	6 Exposition dynamos,	50 lts. each, total, 300 lights
Standard plant:	22 Exposition dynamos,	50 lts. each, total, 1,100 lights
Fort Wayne plant:	13 Exposition dynamos,	60 lts. each, total, 780 lights
	1 Exhibit dynamo	60 lts. } total, 140 lights
	1 " "	80 lts. }
Brush plant:	12 Exposition dynamos,	60 lts. each, total, 720 lights
	4 Exhibit "	60 lts. each, total, 240 lights

There are, therefore, 90 Exposition dynamos, having a total capacity of 4,750 lights, and 7, exhibit dynamos, having a total capacity of 480 lights, or a grand total of 99 dynamos, having a total capacity of producing 5,230 lights, all of 2,000 nominal candle power. All these dynamos are regular direct current series machines, and are equipped with standard switchboards and appliances of the respective systems.

In addition to the foregoing, there are, in the terminal station, 160 six-ampere arc lamps, and 228 three-ampere lamps, equivalent to 164 lamps of 2,000 nominal candle power. There are also 351 Helios arc lamps attached to the incandescent circuits, most of these furnishing lights to exhibitors and to the concessionnaires in the Midway Plaisance.

The grounds are lighted by 1,421 lamps, of which 1,308 are upon ornamental iron lamp posts, and the remainder, which light the fences and the south grounds, upon 40-foot wooden poles.

The grand total of all arc lamps in the plant at the present time is equivalent to 5,362 lamps of 2,000 nominal candle power. The outside circuits are all carried underground, excepting those south of Machinery Hall and along the fences. In the duct trunk line and in all underground ducts, the conductors are of No. 8 B. W. G. rubber covered safety wire, having an insulation of ⅛ inch Para rubber compound, a part having mechanical protection of lead, and the remainder being protected by two tapes wound in reverse. Ninety miles of this wire are used. The circuits in the main subway and in buildings are of No. 8 B. W. G. safety wire, having a covering of 74 mils thickness

DISTRIBUTION OF ARC LIGHTING.

Building.	Main floor.			Gallery.			Total lights inside.	Average sq. ft. per light	Loggia and court lights.	Total number lights.	Remarks.
	No. lights.	Sq. ft. per light.	Distance apart.	No. lights.	Sq. ft. per light.	Distance apart.					
Machinery	238	1,497	25						26		
" Annex	188	1,516	25				411	1,505	Loggia.	437	
Horticultural dome	37	1,113	24	36	856	28					
" curtains	52	815	25				200	951	17		
" pavilions	48	1,197	34	27	1,049	30			Courts.	217	
Anthropological	55	1,886	35	32	1,499	38	87	1,743		87	
Manufactures	389	1,687	30	314	1,828	40			70		
" coronas	414	1,048					1,117	1,499	Loggia.	1,187	
Agriculture	202	1,826	30	165	1,345	40					
" Annex	81	2,022	50				448	1,684	16 Loggia.	464	
Mines	113	1,998	30	64	1,904	40	177	1,964	8	85	
Fisheries	28	2,132	40	14	1,446	40	49				
" W. pavilion	7	1,951	45					1,910		49	
Illinois State	33	1,421	25	39	445	40	71	898	6	78	
Transportation	181	1,346	33	130	1,230	32	311	1,298	6		
" Annex	149	2,445	45				149	2,445	Clère.	466	Helios arc.
Leather	48	1,470	45	31	1,669	41	79	1,712		79	
Forestry	59	1,483	35				59	1,483		59	
Totals and average for main buildings							3,159	1,544	149	3,308	
Miscellaneous buildings										18	
Total lights in buildings										3,426	
Total inside area											4,877,965 sq. ft.

of rubber and braided. Of this wire there are about 200 miles. The grounds and all the buildings are supplied with 2 entirely independent circuits. One set of evening circuits has single carbon lamps calculated to burn from dark to the closing hours of the night. The other set of circuits, which comprise about 10 per cent. of all the lighting on the grounds, is used for patrol or all night lighting.

The feature of the arc lighting is undoubtedly the lighting of the central nave of the Manufactures Building. Here the lights are suspended from five great fixtures or coronas. The space to be lighted is 1,268 feet long and 368 feet wide. The coronas are suspended 140 feet from the floor. The central corona is 75 feet in diameter and carries 102 lamps. The other four coronas, which are equally distributed along the main longitudinal axis of the building, are 60 feet in diameter and carry 78 lights each, making a total of 414 lamps. The coronas, which are made of angle iron, are circular hanging galleries, in which the trimmer can walk from lamp to lamp. They are reached by iron ladders from the trusses above. The great arched roof of the building acts as a reflector for the lamps, and the lighting, as it appears to the eye, is absolutely uniform.

SEARCH LIGHTS.

There are at present installed four Schuckert search lights on the four corners of the Manufactures Building. These lamps are operated from the 180-k. w., 120-volt pound wound for 250 volts, are connected to a three-bar bus system, which feeds the field of all the large dynamos.

The second story of the board is the circuit board, carrying instruments and switches for 40 circuits or feeders, and the whole system is so arranged that any dynamo can be connected to supply current to any of he 40 feeders.

The 12 large machines are wound for only 7,200 alternations per minute, thus supplying current which can be used with perfect success in supplying arc lights. Each large machine, as before stated, has two independent armatures. These armatures are so connected that the two circuits from each dynamo carry current different in phase by 90 degrees, so that any of the large machines may be used to furnish current for operating either incandescent or arc lamps, or two-phase motors.

The distribution of incandescent lighting is shown in the following table:

EXPOSITION LIGHTING.

LIGHTING INSIDE OF BUILDING.

	Lights.	
Administration	2,949	
Agricultural	728	
Music Hall, Casino and Peristyle	4,122	
Gallery Fine Arts and Annexes	17,774	
Manufactures	1,113	
Machinery Hall and Annex	1,772	
Woman's	3,272	
Miscellaneous	6,064	
Total inside lights		37,794

ondary or inside circuit could ever put out more than 200 lights. The secondary wiring is controlled in all cases by switches and cut-outs located at points where wires enter the buildings, and the circuits are in general distributed from asbestos lined boxes in which cut-outs and switches are bunched at centres of distribution. The inside wiring is done entirely with the best grade of Grimshaw rubber covered and taped wire, and the wires are run almost entirely in standard molding or in interior conduit. The lamps, which are of 105 volts, are all the new stopper lamp of the Westinghouse company. The general standard of the Exposition lighting for lamps suspended at the ordinary height from the floor is 40 square feet of floor surface per 16-c. p. lamp, but, inasmuch as the plant presents almost every variety of an incandescent lighting problem that can be thought of, the intensity of lighting varies greatly, ranging from 18½ square feet per 16-c. p. lamp in the Gallery of Fine Arts, and 7½ square feet per 16 c. p. lamp in the smallest gallery, to 3,700 square feet per 16-c. p. lamp for the system of patrol lighting under the floor of the Manufactures Building.

The most novel lighting is the lighting of the tanks in the Fisheries Building, the aquaria being lighted only by invisible lights shining through the water of the tank.

The most brilliant lighting is the lighting of the Gallery of Fine Arts, where the lamps are placed in reflecting

THE STATUE OF THE REPUBLIC UNDER THE SEARCH LIGHT.

Siemens dynamo in the British Section in Machinery Hall. Two lamps are of 150 ampères, one of 100 ampères and one of 60 ampères. The diameters are respectively 60 inches, 44 inches, 36 inches and 24 inches. The 60-inch lamp on the northwest corner is the largest and most powerful ever built, and gives a beam having an intensity of 194,000,000 c. p.

INCANDESCENT PLANT.

All but a small portion of the incandescent lighting of the Exposition is supplied from the Westinghouse plant. This plant comprises twelve 10,000 light dynamos, six of which are directly connected to 1,000-h. p. engines, and six are belt driven, and two 4,000-light dynamos, also belt driven.

All these dynamos furnish a current of 2,200 volts E. M. F., and are compound wound. Each 4,000-light machine has its own exciter, but the twelve 10,000 lighters have their fields excited by three 100-h. p. exciters which are operated in multiple arc. These machines are all connected to an immense switchboard, which is the most striking object in the electrical plant. This switchboard, which is of white marble, is arranged in two stories or sections. The lower, or dynamo, board controls all the dynamos. Each large alternator is a double machine, having two independent armatures, so that the board practically has connections for 26 alternators and five exciters. The three large exciters, which are com-

EXTERIOR OR DECORATIVE LIGHTING.

Basin and bridges	2,331	
Cornice and dome of Administration	2,049	
Other cornices	3,786	
Total decorative lights		8,166
Grand total Exposition lights		45,960

CONTRACT LIGHTING.

Buildings of states and governments	4,881	
Buildings of concessionnaires and exhibitors in Midway Plaisance	5,416	
Buildings of concessionnaires and exhibitors in Jackson Park	1,947	
Exhibitors and concessionnaires in Exposition Buildings	7,468	
Total contract lighting		19,712
Grand total		65,672

The circuits or feeders are calculated for a loss not to exceed 10 per cent., each circuit being provided with a Stilwell regulator, capable of increasing or decreasing the initial pressure on a circuit of 5 per cent. All circuits, excepting one, to the south grounds, are run entirely under ground. The cables, from the switchboard to converters, are all duplex Waring cables, except in the main subway, where Grimshaw rubber covered wire is run on insulators. All converters are placed in fire and water proof pits just outside the buildings, and the secondary wires are led into the buildings in vitrified tile duct. The largest converter used has a capacity of 200 lights, and nearly all are of that size. Every converter on the ground has its own independent secondary circuit, so that no trouble upon a sec-

screens around all sides of each picture gallery, the lights being only eight inches from socket to socket for nearly two miles of screens.

The finest lighting is undoubtedly that of the Administration Building. The lighting of the interior is wonderfully uniform, and, in conjunction with the exterior decorative lighting, forms probably the most difficult and beautiful piece of incandescent lighting ever executed. In the incandescent lighting of the Exposition it has been the aim throughout to avoid display lighting, but to secure sufficient and uniform illumination, and, where the lights have been placed for decorative effects, to place them so as to be inconspicuous by day, and to bring out at night the decoration or lines of the buildings. Wall sockets have been largely used, and stiff pendent fixtures have been used but in one building, simple clusters hung from flexible cord being almost universally used. This method of construction proves very satisfactory, and has the advantage of being easily and quickly installed, so as always to present a mechanical appearance. It is easily maintained, and, what is important in an exposition, the position of the lights can be easily and quickly changed without disfiguring or damaging the ceiling.

In addition to this lighting, the Siemens & Halske Company, of Berlin, has installed the following incandescent lights:

Wooded Island, 120, 25 c. p.: Choral Hall, 1,740 lights, equivalent to 2,462 lamps of 16 c. p.: terminal station, 567 lamps, 16 c. p., being equivalent in all to 3,117 lamps of 16 c. p. This makes a total of all incandescent lamps equivalent of 68,789 lamps of 16 c. p.

The Siemens & Halske lights are operated from a generator in the German section, Machinery Hall, having a capacity of 700 kilowatts, and furnishing current to the light mains of 440 volts.

The lamps upon Wooded Island are operated in series of four, and incandescent lamps in the buildings are operated upon a five-wire system with equalizing motors at the centres of distribution. The feeders are of armored cable laid direct in the ground. This plant is interesting as illustrating the difference between European and American practices and is the only plant of its kind in practical operation in this country.

POWER.

Although the electric lighting has been carried out on a scale never before approached in an exposition, it is in the transmission of power that the advance of the art of electricity is most conspicuously shown. With the exception of the power in Machinery Hall and a portion of the power in the Mines and Mining Building, all the power which is transmitted from the great power plant is transmitted by electricity, and even in Machinery Hall electricity operates the great cranes, the elevators and a part of the main line shafting. Circuits are so arranged that power can be had in any building and in any portion of the grounds. The generating plant in Machinery Hall comprises the machines shown in the following table:

GENERATORS.

Make.		No. of generators.	Kilowatts.	Voltage.	Total kilowatts.	
Exposition:	Mather........	2	225	550	450	
	Mather........	2	120	550	240	
	"C. & C.".....	4	80	550	320	
	"C. & C.".....	2	80	250	160	
	Eddy	4	186½	550	746	
	Westinghouse	1	373	550	373	
						2,289 kilowatts
Exhibitors:	National	1	80	500	80	
	Jenney	1	40	550	40	
	Wes'n Electric	2	137½	250	275	
	Wood	1	120	500	120	
						515 kilowatts
Grand total..............................						2,804 kilowatts

making a total generating capacity of 2,289 kilowatts, or 3,070 e. h. p., for Exposition use, and 515 kilowatts, or 690 e. h. p., for exhibitors' use—a grand total generating capacity of 2,804 kilowatts, 3,585 e. h. p.

All the generators, except two 80-kilowatt machines which supply the power for the elevators in Administration Building, are regular street railway generators, wound for 500 volts, with a guaranteed electromotive force of 550 volts at full load. Each type of machine has its own independent switchboard, but relay circuits are run between boards, so that in case of emergency the feeders from one board can be fed from the generators of another. The circuits are run in the main subway and upon the structure of the elevated railway. The feeders and mains consume 180,000 feet of No. 0000 wire B. & S. gauge, 19,000 feet No. 000 B. & S. wire, 12,000 feet No. 0 B. & S. gauge, and 24,000 feet No. 1 B. & S. wire. This is exclusive of the distributing mains running to the various motors. All the wire is rubber covered and braided, the No. 1 wire having $\frac{3}{32}$ of an inch thickness of rubber, and the larger sizes are covered with $\frac{1}{8}$ inch thickness of rubber. The cable is of the make known as the E. M. W.

The motors used by the Exposition company are all supplied by the General Electric Company, with the exception of two 150-h. p. Westinghouse motors operating shafting in the Mines and Mining Building. Exhibitors provide their own motors of each type as they wish. The applications of electric power are almost universal, as electric motors are used to operate almost every kind of machine in use by the Exposition or displayed by exhibitors.

The distribution of light and power as shown in the tables is exclusive of the electric power consumed in the Electricity Building. This building consumes all the electricity generated by the machines designated as exhibit machines, the electricity being used for light, heat and power, and for producing the many electrical effects displayed in the Electricity Building.

ELECTRIC LAUNCHES AND ELECTRIC FOUNTAINS.

The four 150-kilowatt Edison dynamos furnish current for operating the electric fountains in the evening, and for charging the storage batteries of the electric launches after 10 o'clock at night.

Each fountain is illuminated with 19 80-ampère Knowles arc lamps, requiring in all 300 kilowatts or 400 e. h. p.

The launches, 58 in all, are each equipped with a motor of 4 h. p. operated by a storage battery of 78 cells.

The circuits of both fountains and launches are of Edison underground tubing, and are arranged as a three-wire system.

In the north aisle of Machinery Hall is the electric traveling crane of the Morgan Engineering Works, equipped with seven motors of the General Electric Company's manufacture. In the central aisle is the Yale & Towne electric traveling crane, and in the south aisle is the Wm. Sellers & Co. crane, all three of 20 tons lifting capacity. All motors are under the control of the operator in his cage at one end of the crane, and can be run together, independently or in any combination.

Going from Machinery Hall, east of the Administration Building, to the Electricity Building one passes the Electric fountains. Admission to the operating casemates of the same will be gladly accorded to engineers upon application at the office of the General Electric Company. The fountains have proved one of the most intensely interesting features of the illumination at the World's Fair and have been fully illustrated and described in THE ELECTRICAL WORLD of Jan. 21 and May 13.

THE ELECTRICITY BUILDING.

This building, covering an area of 350 by 700 feet, is most beautifully situated, looking out from its south portals upon the Grand Plaza, the Administration Building, the Electric and McMonnies fountains. Its greatest length is north and south. To the east is the great building of the Liberal Arts and Manufactures—the largest building in the world—and to the west is the Mines and Mining Building, in which are displayed the products of the earth's interior and the means of cultivating these crops.

Having thus re-established in our minds the points of the compass, we enter the building from the south through the great hemicycle portal, stopping for a moment to admire the colossal statue of Benjamin Franklin, by Carl Rohl-Smith. This statue is the only one of prominence connected in any way with the adornment of the Electricity Building. It is a finely executed piece of work and represents our first philosopher, whom American electricians so delight to honor, with head thrown back and face upturned, suggestive of his familiar kite experiment. Both the subject and its execution are worthy the place of honor accorded to it, and will well repay a closer study than we can afford to give it in the hasty trip upon which we are engaged.

On the exterior of the building few attempts at ornamentation have been made, but those few are appropriate. Electrical symbols, for such they must be considered, so rapid has been the progress in electrical development, abound, and on all sides are emblazoned in staff the names of those to whom this rapid advancement as well as the pioneer work has been so largely due.

One of our contemporaries delights to add the initials of another noted man—this time a journalist who has elevated himself to chronicling the electrical advancement and triumphs of others, and to him it has accorded the most prominent position of all—the centre of the great hemicycle—but we are reliably informed that these initials will not be placed there in enduring brass or stone, or even staff as they deserve, since the authorities have decided that this honor shall be reserved for those who are dead. If this qualification be insisted upon, long may the initials of G. B. M. remain off from the niche of fame, to which otherwise they are entitled.

Entering the doors we turn to the left and ascend first to the gallery floor. There are several reasons for this direction to our steps, the main one being that from the gallery floor the best general idea of the interior of the great building is to be had, and another that upon that floor are the executive offices of Chief Barrett and Mr. Hornsby, of the electrical department, to whom so much of the success of the electrical display is due, and the headquarters of the American Institute of Electrical Engineers, which it is hoped all visiting electricians will make their own while at the Fair.

Turning to the right at the head of the stairs and walking a few feet to the south we enter a door over which has been hung a modest sign bearing the words

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

All the visitors to the building, whether they be members of the Institute or not, are invited to enter and register their names in a book provided for the purpose. This book is likely to become in time of extreme historical interest, for already there are inscribed upon its pages the autographs of many of the most illustrious living electricians in the world, and it is hoped that many more will be added during the week of the Congress.

Mr. Ralph W. Pope, secretary, and Mr. W. J. Hammer, the official representatives of the Institute, will be there to welcome all, and will insist upon each contributing his share to the prospective historical value of this book.

The quarters of the Institute comprise two rooms, an inner one, looking out upon the Court of Honor, and an outer one, whose window looks out upon the statue of Franklin, and the hemicycle where G. B. M. is not.

The inner room is Mr. Pope's sanctum and is comfortably furnished as a place for appointments among friends and a place to talk over old triumphs or to plan new ones. Advantage should here be taken of the opportunity for a social smoke, as smoking is not allowed elsewhere in the building, except in the restaurants at the further end.

Lest we may have aroused expectations that will not be realized, it may be well to state here that the visitors are expected to furnish their own cigars, as the Institute does not officially know each individual's favorite brand.

While smoking, the time may be most interestingly spent in examining the historical exhibit which has here been collected. Mr. Hammer and Mr. Pope have been untiring in their efforts to make this exhibit interesting and instructive, and the former has himself contributed much from his own private collection. How successful they have been, the mere catalogue of the exhibits will show.

THE INSTITUTE HISTORICAL COLLECTION.

In an oak frame on the south wall are samples of some of the materials used by Thos. A. Edison in his early experiments with filaments for the incandescent lamp. These are from the collection of Mr. W. J. Hammer, and are already of historical interest because they cannot be duplicated.

On the west wall, in a similar frame, are the floor plan and description of Davidson's electric locomotive, which was in regular service between Edinburgh and Glasgow in 1842.

Near by, in a glass case, is a model of Davenport's electric motor and railway, lent by Mr. Geo. M. Phelps. Just how old this model is is not known, but its existence has been positively traced to prior to 1840. A fac-simile of Davenport's application for a patent, dated 1835, is also shown.

Just above this glass case is a large photograph of several hundred lamps, including less than half of the incomparable historical collection of lamps of Mr. Hammer. Photographs of a few of these were presented as exhibits in the Columbia incandescent lamp case at St. Louis, and were reproduced in THE ELECTRICAL WORLD'S report of that case in the issues bearing dates of April 22 and April 29, 1893.

On the same side of the room, hung in a frame, are two original handbills, which, the label tells us, were printed by Davidson's improved (!) electric motor of 1823.

On the north wall is an exact reproduction of a newspaper published on the train by Thomas A. Edison at the age of fifteen.

Beneath it is another frame, containing a small piece of office wire, which is part of that used in the original experiments by Bell, which resulted in the invention of the telephone.

Near by are small portraits of William Thomson, Joseph Henry, Thomas A. Edison, William Siemens, Michael Faraday and Helmholtz, and in the centre of this group is a composite photograph of them all.

On the east wall is the original medallion made of Franklin in Paris in 1777. Near by is a photograph of an old engraving—date not known, but traced back into the last century—showing an experiment with static electricity. The frictional machine, the insulated stool and the Leyden jar are clearly and interestingly shown. This photograph was presented to the Institute by M. E. Hospitalier, one of the Commissioners of the French government to the Congress.

Nearby is shown what is claimed to be the first arc lamp made in America. This is composed of two plates of carbons, each about 6 inches wide. It was made in 1875 by Mr. William Wallace, of Ansonia, Conn. Just below it is another one made by the same person, of two narrower carbon plates, and is one of the first four arc lamps ever run in series. It is called the "improved W ate lamp" and was made in 1875. Both of these are loaned by Mr. William Wallace.

To the south in a frame is the original of Franklin's famous letter of July 5, 1775, to Mr. Strahan. This is loaned by Mr. William Wallace, also.

In the southeast corner of the room a small but choice reference library of standard electrical works has been provided for the convenience of visitors.

In the outer room the walls are well covered with Mr. Hammer's extensive collection of portraits of electrical celebrities. Besides these are the original call for the organization of the American Institute of Electrical Engineers, bearing all of the original signatures and the date of the meeting, May 12, 1884, and above it one of the new certificates of membership of the Institute, made out in the name of Benjamin Franklin.

In the southeast corner of the room is a letter file; for those desiring it may have their letters addressed during their stay at the Fair, either to the care of THE ELECTRICAL WORLD or to the care of the Institute, Electrical Building. Those addressed to the latter are posted here.

Beneath the letter bulletin is a model of the Wallace 48-carbon arc lamp of 1877.

In the centre of this room is a large table upon which are kept the files of the leading American and foreign electrical journals.

Having finished our smoke by this time let us proceed to an inspection of the exhibits on the gallery floor.

THE SOUTH BALCONY.

Passing out from the Institute rooms, and turning to the right, we come upon the south balcony, which extends across the south end of the building and connects the Southwest and Southeast galleries. From this an excellent view up the grand nave is obtained, but the best view is obtained from either side of the centre. Immediately beneath is the beautiful American Bell Telephone pavilion, or, rather, its roof, for this is all that can be seen from this point of view. Just beyond, but hidden by this building, are the street railway exhibits of both the Westinghouse Electrical and Manufacturing Company and the General Electric Company. Towering up above all else, the most prominent feature of the picture, is the Edison Tower of Light, surmounted by the colossal prismatic lamp bulb and the lamp sign of the company. The base of this pillar, which is shielded by a canopy, is the exhibit of the Phoenix Glass Company. The Edison column forms the exact centre of the building, and rises from beneath the intersection of the nave and transept. Surrounding this column on all sides, and radiating out from it like the petals of a full-blown flower, are the various departmental exhibits of the General Electric Company.

In the alternating current department of the General Electric Company Prof. Elihu Thomson's celebrated high potential and repulsion coil experiments are shown daily at 3 and 8 p. m. In the former sparks 64 inches in length have been obtained. To produce these the regular 1,000-volt current is first transformed down to 57 volts which raises it to 5,000 volts. It next passes through a spark gap upon which is maintained a blast of air and goes thence to four condensers. From these latter it passes through an oil transformer which raises its potential to from 1,000,000 to 1,500,000 volts.

To produce the repulsion coil phenomena a current of from 90 to 110 ampères at 52 volts is used.

Next in point of prominence in the landscape is the General Electric Company's fan sign, which marks the northern boundary of their exhibit and hides from view at this point all that lies beyond on the main floor, but just beyond is another exhibit of the Westinghouse company, which is known as the "Transmission of Power" exhibit of the Tesla system, and beyond this a portion of the French exhibit.

THE EAST FACADE OF ELECTRICITY BUILDING.

In the Westinghouse exhibit are daily shown two series of experiments of the greatest interest. One shows the rotative effect of the Tesla ring. An iron ring wound with two pairs of coils at right angles to each other, the two pairs of coils traversed by alternating currents differing in phase by 90 degrees, is set into action, causing everything of a metallic nature in its vicinity to rapidly revolve. Each pair of coils is traversed by a current of 200 ampères at 7,200 alternations. The energy expended in this ring is therefore in the neighborhood of 40 h. p.

In the dark room prepared for the purpose, adjoining, are shown the high potential experiments where the regular Westinghouse alternating current of 7,200 alternations and 1,000 volts is transformed by means of oil transformers up to from 40,000 to 60,000 volts, and the terminals of the transformed circuit are brought to pieces of tinfoil pasted on either side of a large piece of plate glass. The sparks, unable to pass directly through the glass, spread out in all directions over its surface and find their way around the edges. These experiments are shown usually at fifteen-minute intervals between 1:30 and 5:30 p. m. on Tuesdays, Thursdays and Saturdays, but during the week of the Electrical Congress will be shown daily.

At the extreme north end of the building, occupying the whole of the north balcony, the Ansonia company's pavilion looms up in great prominence, and above it on the north wall, in large letters of warm colors, is the sign, without lamps, of the Fort Wayne Electric Company. The gallery exhibits overlooking the ground floor also show up well from this point, but as we are about to examine them at shorter range we will defer mentioning them for the present.

Turning around and examining what is nearest us we see to our right Paiste's display of eccentric switches, with the name "XNTRIC" wrought in the material, of which it is the designation. Near by is a modest door, which, if we be curious enough to enter, will be found to lead to a suite of rooms connecting with the Institute rooms; that suite has been set apart as the headquarters of the Jury of Awards.

Each juryman has been provided with a suitable desk and chair, and here may be found at times the various members of this most important body, individually known, by reputation, at least, throughout the length and breadth of the land.

Along the south wall are also seen the exhibits of the Long Distance and Municipal Single Line Printing Telegraph Company, printing telegraph instruments; the Dulaney Clock Company, electrical clocks; the Columbian Electric Generator Company, hand magneto machines.

Raising our eyes we see the great Westinghouse Electric Manufacturing Company's sign, covering the whole south wall above the balcony floor. All of the lamps here employed are of the separable or stopper type.

The lamps composing this display are distributed as follows: In one scroll there are 398 lamps, and in the other 387. The bust of Columbus is outlined in 390 lamps, and his name in 165. The two dates required 95 and the name of the company 650 lamps, making a total of 2,085. These are all 16-c. p. lamps, so called, and at this rating would give a total illumination equivalent to 33,360 candles. This is not the actual illumination, however, for the attempt has been made to accentuate some of the lines by introducing into the design lamps of different voltages. The current delivered to all of the lamps is at 101 volts, and the lamps in the eye, eyebrow, nose and mouth are rated at full candle power at 98 volts. The profile and part of the face and a few in the hair are of 101 volt lamps—the bulk of the hair, the bust and the feature lines of the face are 107 volt lamps. The date and the word "Columbus" are of 104 volt lamps, while the firm name is built up with 101 volt lamps—all the rest being 107 volt lamps.

Retracing our steps to the

SOUTHWEST GALLERY

we find the entire south end occupied by the Edison phonograph display and that of the Edison Manufacturing Company. In the former, the phonograph is very much in evidence, and among other things shown is a sort of phonograph exchange—an arrangement by which the different offices of an establishment may be connected by means of speaking tubes with phonographs in a separate apartment where also the typewriters are located. The adaptation of the phonograph to educational purposes—chiefly the teaching of languages, is also shown, and this will form, for many the most interesting feature of the exhibit. The Edison Manufacturing Company shows the well known goods of its manufacture, one of the best known of which is the Lalande battery.

In the immediate vicinity, but to the north, are the displays of the Illinois Alloy Company, journals, trolley wheels, etc., into which their alloy enters; the Roessler & Hasslacher Chemical Company, a large glass case containing the chemicals of their manufacture, including Isolatine and Isolatine varnish and their applications; the National Engraving Machine Company, the electric light cure for blood and eye diseases—this is evidently a relic of the Gen. Pleasanton blue grass theory elaborated; Hart & Hegeman, switches; Herlimann electric batteries; Buckley & Knapp, lightning rods. The India Rubber Comb Company, and the Goodyear Hard Rubber Company, adjoining the latter, show a handsome case of their hard rubber goods suitable for electrical purposes. The Hope Electrical Appliance Company show a line of their cut-outs, arc lamp hangers, etc.—these are all new to the trade and were described in full in THE ELECTRICAL WORLD for July 1—and the Empire China display. This completes the south end of the gallery. In the centre of each of the four galleries there is a well opening out upon the exhibits on the ground floor. On either side of this well is a broad aisle upon which exhibits face, and there are also two other aisles, one along the wall and the other along the gallery railing overlooking the main floor. Taking the latter first and going north, the exhibits are all on our left. The first one encountered shows electric headache cures, electric brushes, *et id omne genus*, and by the way there are several exhibits of this kind not far from here and those who wish to examine electric belts, etc., may pause, but let us pass on.

The Enterprise Electric Company's electrical supplies and the beautiful Moorish temple of the Eureka Tempered Copper Company, fully described and illustrated in THE ELECTRICAL WORLD for June 17, first attract attention. Next comes the display of the Electrical Appliance Company. The pavilion occupied by this company is roofed in with over a hundred miles of flexible cord —the first that was made by the manufacturers of the Paranite wire, one of the specialties for which this company is agent. The Packard lamp sign, the reels of O. K. waterproof and Paranite wires, Meston fans, Whitney electrical instruments, Iona specialties, Elkhart converters and many other well known goods may be examined here in detail.

The Electric Selector and Signal Company show a full line of their specialty—selective signals, applied in all conceivable ways—and many who have time will find it profit able to examine into the system closely.

THE RADIOPHONE.

On a small platform extending out beyond the gallery floor, just opposite this last exhibit, is the transmitting apparatus of the Bell radiophone, described in THE ELECTRICAL WORLD for Aug. 5. The apparatus consists of an ordinary focusing arc lamp, whose rays rendered parallel by passing through a lens are reflected from a plane mirror to the receiving instrument which will be seen on the north front of the Bell telephone building on the ground floor. This is merely a parabolic reflector in the focus of which is placed the bulbed end of a small glass tube containing burnt cork. To the other end of this glass tube is attached an ordinary phonograph hearing tube. There is no local circuit in the receiving instrument; in fact, nothing electrical about the radiophone, except that in the absence of sunlight an arc lamp is used as the source of light.

The action is briefly this: The reflecting mirror in the transmitter is a disc of thin silvered glass held between two rings of blotting paper in a heavy brass frame. It is also a diaphragm which vibrates in unison with the words spoken into the mouthpiece behind it, varying the intensity of the reflected light and heat rays which are concentrated on the carbonized cork in the receiver. The absorption of these rays of varying intensity by the cork produces sound waves in the hearing tube, so that the latter are purely mechanical. This instrument must not therefore be confounded with the photophone, in which the variation of light rays falling upon a selenium cell vary the strength of a local circuit in which is placed a telephone receiver The distance between the two instruments in this case is about 90 feet, but under favorable conditions sounds may be transmitted a quarter of a mile. The articulation is not good even at 90 feet, but the idea of transmitting a message on a ray of light without the aid of the electrical current is here interestingly exemplified.

An excellent view of the ground floor, or rather the south half of it, is also here obtained.

The H. W. Johns exhibit, described and illustrated on June 10, occupies all of the north end of the space between this aisle and the one to the west. Vulcabeston, Monarch insulation and molded mica, in all the manufactured shapes, are here attractively shown. Overlooking the ground floor is a handsome sign on which the word "Insulation" and the company's name, H. W. Johns Manufacturing Company, in different colored miniature incandescent lamps, are alternately flashed.

Passing around this display and proceeding south in the aisle to the east of the well, we have on our right (west) the McIntosh Battery and Optical Company, showing electro-therapeutical apparatus, and the S. S. White Dental Manufacturing Company, with a fine display of electrical dental tools and Partz batteries. On the left, or east, side is the Electrical Engraving Company, where samples of glassware electrically engraved may be bought for a small sum. The graving tool employed is a platinum loop heated to a white heat by electric current. With this the figure is traced on the glassware, which is then scratch-brushed, leaving the figure more or less incised in the glass.

The Union Brass Company comes next on the south, showing a large line of their well known steam fittings.

Adjoining this is the C. F. Hall electroplating exhibit in which the actual operation of electroplating in gold, silver and nickel is practically shown.

The Electrical Appliance Company exhibit also fronts on this aisle, and to the south of this is the display of the McNeill-Tinder Electric Company. This firm shows a new and very useful instrument, viz., a recording meter for recording the exact time a circuit is in use. This instrument, which is unobtrusive in appearance, is intended to be inserted right in the circuit, and when so placed makes an automatic record of the time during which that circuit is in operation. Instruments are shown in operation here, and central station men especially will probably stop to investigate.

Going north on the aisle to the west of the well, skipping over the electric belts, we come first to the display of the Central Electric Company, in which are shown large reels of the well known Okonite wire, a sample board of carbons of all sizes and shapes made by the Washington Carbon Company, and two large sample boards of the Interior Conduit Insulation Company's goods and specialties, for which the Central Electric Company are agents.

In the space just north of the well and backing on the space occupied by the S. S. White Dental Company, is the display of the Waite & Bartlett Manufacturing Company, consisting chiefly of electro-medical instruments. One of the most interesting pieces of apparatus here displayed is an enormous Holtz induction machine, driven by a small electric motor. This is said to be the largest machine of the kind in the world.

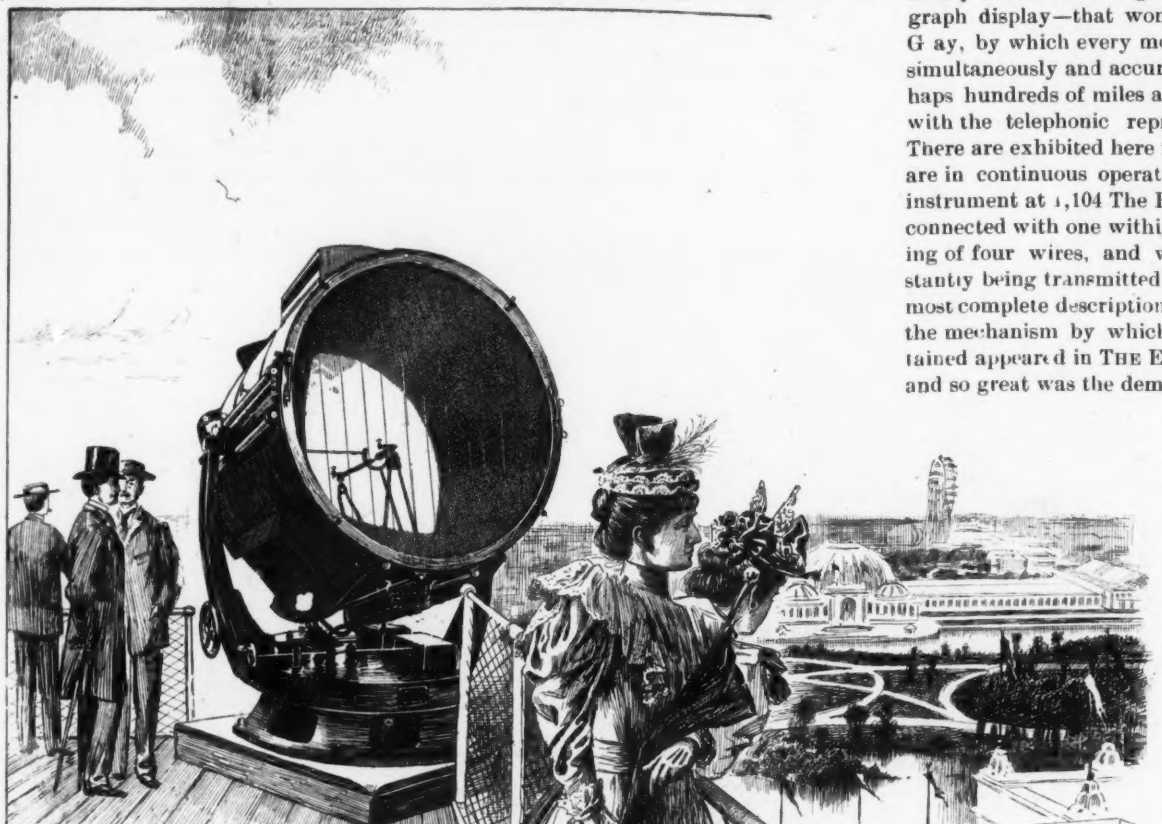
Just beyond the display of the McIntosh Battery and Optical Company, which we pass again, are one of the two big flights of stairs found on each side of the gallery floor leading down to the ground floor. Just north of this stairway is the exhibit of J. C. Vitter & Co., electro-medical apparatus, which completes the list of exhibits in the Southwest Gallery. This latter is connected with the Northwest Gallery by a wide balcony extending across the west end of the nave. On this there is a single exhibit, that of the Star Iron towers for arc lamps and visual signals.

From here we get another fine view of the floor below, including the General Electric Company's display, the Tower of Light, and under the Northwest Gallery a part of the fine German display, including that of Felten & Guilleaume, the Allgemeine Elektricitäts Gesellschaft, Hartmann & Braun, and at the further end of the nave in the gallery the German historical exhibit with the bust of Werner Siemens in the centre. The Northeast Gallery, as seen from this point of view, shows the exhibit of the Imperial German Postal and Telegraphic departments, and the Southeast Gallery the Gamewell fire alarm, the Strowger automatic telephone exchange, the Reliance gauge, the Simplex Electrical and Kerite displays.

THE NORTHWEST GALLERY.

Passing around to the southeast corner of the Northwest Gallery one of the finest views of the building to be had presents itself. The General Electric Company's fan no longer hides the Westinghouse and French lighthouse exhibit of Barbier et Cie. to the north and the beautiful golden pavilion of the former company and its surrounding display of Tesla power-transmission apparatus, and the revolving glass domes of the lighthouse are visible to the north; the great Edison tower and a large part of the General Electric Company's exhibit, the Westinghouse street railway display and the classic Bell telephone pavilion lie before the observer to the southeast and south. With a sweep of the eye the two eastern galleries come within the view, as well as the north and south balconies with their varied exhibits.

Following the aisle along the railing overlooking the main floor and turning north, we have on our left, after passing some electric belts, N. C. Gault & Co.'s display of Schoonmaker's patent copper lightning cables, showing the machinery of manufacture in actual operation. Passing still another electric belt display we come to an adaptation of the electric motor to the manufacture of clothing on a wholesale scale, viz., an electric cloth cutting machine. This is the exhibit of the Caldwell Electrical Cloth Cutting Machine Company, which, when in operation, attracts great attention.



THE GREAT SEARCH LIGHT.

Just north of this is the Tate Automatic Electric Signal Company's display, which consists of a number of tracks equipped with their signals and two miniature electric locomotives which run over the course prescribed for them, showing in an interesting manner the operation of the apparatus.

Beyond is the Eco Magneto Clock exhibit of watchmen's clocks, and next to this the Austrian exhibit, consisting chiefly of electro-medical and surgical apparatus.

The extreme end of this block is occupied by the tasteful display of Newman's watchmen's clocks, a number of which arealso in regular service in various parts of the building Turning around Mr. Newman's display and going south we have on our left a long series of booths or stalls—all built very much alike, but each furnished according to the tastes of the occupants This has become known as Newspaper Row, because here are located the Exposition offices of all the American electrical papers. Directly opposite—across the well—is the French musical exhibit, chiefly of pianos and hand organs, but as there is nothing electrical about them we will give them no further attention.

The first two stalls of Newspaper Row have other tenants than newspapers. In the first is found the display of the Electric Heat Alarm Company, in which their very useful instrument is shown in operation. Short lengths of shafting, on the bearings of which the thermostat has been fixed, are electrically heated for the purpose of throwing the local alarm circuit into action. Next to the south is an unadulterated fake, which is exhibited as a magnetic eye cure. It has neither magnetism nor electricity about it.

The papers are passed in the following order as we go south: *The Electrical Review, Western Electrician, Electricity, Electrical Engineer*, THE ELECTRICAL WORLD, *The Street Railway Journal* and *Electrical Industries.*

THE TELAUTOGRAPH.

Passing over to the southwest we come to one of the most interesting, if not the most interesting, exhibit in the whole building, and we have purposely reserved this until nearly the last before going to lunch. It is the telautograph display—that wonderful invention of Prof. Elisha Gray, by which every motion of the pen at one place is simultaneously and accurately reproduced at another, perhaps hundreds of miles away, with a fidelity comparable with the telephonic reproduction of the human voice. There are exhibited here nine pairs of instruments, which are in continuous operation from 10 a. m. to 5 p. m. An instrument at 1,104 The Rookery, eight miles away, is also connected with one within this inclosure, the line consisting of four wires, and written communications are constantly being transmitted and received over this line. The most complete description that has ever been published of the mechanism by which these wonderful results are obtained appeared in THE ELECTRICAL WORLD for March 25, and so great was the demand for this number that had the edition not been unusually large it would have been exhausted in a few days.

In the immediate vicinity is another most interesting display, viz., that of the Commercial Cable Company, wherein cable telegraphy is fully illustrated. Here writing at a distance by means of the siphon recorder is also shown, but it is not autographic as we all know. One may with profit spend much time at this booth, for there are gentlemen here who are glad to explain all of the mysteries and details connected with the operation of "writing beneath the sea."

LUNCH.

Those who are so disposed will now proceed to the north end of the building to the cafés, which occupy both of the great bays. If the day be warm the tables in the open air on the porch between the bays will be found most agreeable, otherwise the inclosures will be preferred. Meals are served here by the card and the charges are fairly reasonable. Wines and beer may be ordered, and smoking is permitted, both in the inclosures and on the porch.

THE NORTH BALCONY.

This is wholly occupied by the Ansonia company's exhibit, which includes among other things a free electric elevator of the Frisbie Elevator and Manufacturing Company make, of New Haven, Conn. This elevator runs at short intervals between the main and gallery floors, and has proved a boon to the public. Another striking exhibit is that of the new Sunbeam lamp. This was the result of the lamp litigation, which placed a premium upon non-infringing lamps. The new Sunbeam is what is termed a gas lamp, and as it is made partly of platinum, contains neither a vacuum nor an all-glass receiver, and the leading-in wires are not sealed into the glass; it is thought, therefore, not to infringe.

HISTORICAL.

Quite an interesting historical display is made by the Ansonia company in the shape of, first, the first dynamo constructed and operated practically in the United States, date 1873, second one bearing date 1875; third one dated 1876; and said to be the first dynamo in the United States constructed with an armature built up with laminated plates. All these three were built by Mr. Wm. Wallace, of Ansonia, Conn. There is also a fourth of not less interest, which was constructed under the supervision of Prof. Wm. A. Anthony, at Cornell University, in 1874 or 1875, and which for some years supplied current for the Wallace plate carbon arc lamps. A very fine view, perhaps the best of the building, is to be had from the Ansonia exhibit

NORTHEAST GALLERY.

This space is wholly occupied by German exhibits, most of which, however, are not in any sense electrical, and therefore will interest us but little at this time. In the southwest portion of the gallery, however, there is an exceedingly complete and interesting exhibit of the Imperial Postal and Telegraphic departments.

Just south of the stairway is a handsome pavilion of the Leclanché Battery Company, and to the east, against the wall, is located the Western Union Telegraph Company. Besides handsome busts of Morse and Field and the modern instruments their energy and invention brought into demand, there are also some things here of exceeding historical interest. Among these are a photograph of the original message in Morse characters, "What hath God wrought?" and an original Morse receiving instrument made of wood; this is 3 feet long by 2½ feet high. Beside it for comparison is placed a modern Morse receiver, 1893 model, whose dimensions in inches are about the same as the original's in feet. There is still another historical (?) piece, viz.: a grapnel bearing a placard stating that the 1865 cable was picked up with *this* grapnel on Sept. 2, 1868. It is about 4 feet high and looks rusty and ancient enough to be genuine, but it should be screwed down to the floor, for some visitors are inquisitive enough to test its weight, and such find that they can hold it up from the floor at arm's length for several seconds at a time. This makes them doubt its genuineness.

THE EAST BALCONY.

This is occupied by a very handsomely displayed and interesting exhibit of historical German electrical apparatus—the most extensive historical collection in the building. This is well worthy of extended study, and those who have time will return for this purpose, but we must pass on to

THE SOUTHEAST GALLERY.

Along the railing and facing west, as we go south, are the extensive and interesting displays of the Gamewell Fire Alarm Company, the Strowger Automatic Telephone Exchange, the Reliance Gauge and George Cutter's specialties, and backing on these and facing to the east are the displays of the Pumpelly and Sorley storage batteries, and at the extreme south of this block is the handsome exhibit of W. R. Brixey's Day's Kerite. This latter, besides showing everything from the growing rubber plant to the Kerite insulation on cables of all kinds, also exhibits something in which great pride is taken, and which may be termed an historical exhibit, viz., two medals—one awarded at the Centennial in 1876, and the other in Paris in 1878.

Passing east from the Kerite exhibit we have on our right the exhibit of the Weston Electrical Instrument Company, which is very extensive and most attractively displayed. Much time can profitably be spent here in examining these standard instruments. Next on the right are the switches of the Bryan Electric Company, and in this same block are found the displays of the Billings & Spencer Company, of Hartford, Conn., drop forgings of all descriptions, and W. P. Stevens' patent process of splicing refuse carbons.

Returning and going north on the east side of the well, we have on our right, and terminating this block, the display of the New York Insulated Wire Company, which consists of pyramids of their White Core and Raven Core Grimshaw wires and a unique log cabin built of Vulca ducts. Next comes the New England Butt Company with its display of braiding and twisting machines, which, when in operation, always attract the visitor.

The National Carbon Company has a very extensive display of all kinds of carbons used by the electical fraternity, and these have been arranged in attractive architectural designs.

Near by is a glass case containing the Warth electrical torpedo gun, intended, like the Zalinski gun, for firing nitro-glycerine projectiles. The expulsion of the projectile is accomplished without the use of explosives of any kind, but simply by electrical means.

The Chicago Electric Wire Company and the Norwich Insulated Wire Company both make fine displays of insulated wires to the north of this.

Going still further north to the left of the stairway, we have on the left the official electrical exhibit of the Republic of Brazil, which will be found quite interesting. This consists chiefly of telegraph and fire alarm apparatus, and electrical measuring instruments used in the government telegraph service. Turning around the north side of the stairway, we have on the right the attractive little display of the K. A. P. Electrical Novelty Company, which shows a revolving globe upon which the continents are outlined in miniature incandescent lamps and a moving belt studded with large lamps—all inserted in the K. A. P. sockets. Just in front of us is the extensive wire display of the Washburn & Moen Manufacturing Company. This is but one of several made by this company—the others, equally extensive, are to be found in the Manufactures and Mining buildings.

Going south again, along the easternmost aisle, we have on our left—first, a curious conceit, viz., Knight's coin-control bootblacking machine, with which, by inserting a nickel in the slot and by properly manipulating one's feet, one can get his shoes blacked by electrically revolved brushes.

Next comes the Union Electric Company's display of Crowdus primary batteries, fan motors, portable electric lamps and a lot of other conveniences manufactured by this company.

The Automatic Guest Call annunciator, Hanson primary battery, the Unique or Referee battery, the Elgin telephone, William Hubbard & Co., J. Rauscher bell pushes and Carl L. Sponholz's telephone directory, grouped closely together, are next in order. Then comes Mr. Carl L. Jaeger's display of his electrical recording compass and electric bug. These are both entirely new and will be found quite interesting. The last on this aisle is the display by the Standard Paint Company, of their P. & B. compounds and tapes, both in original packages and applied.

Passing directly south to the southernmost aisle and going west, we have on our left, first, the exhibit of the Electric Gas Company. This company, strangely enough, produces electricity as a waste product. The apparatus consists simply of a zinc-copper sulphuric acid cell, which is used solely for the production of hydrogen gas by the consumption of zinc, and a carbureter to give this gas illuminating properties. The gas is shown burning, and they would have the gullible public believe that they can generate electricity and throw it away as an incidental product and still make gas more economically than by the usual process.

The Consolidated Electric Storage Company make an attractive and extensive display of their well known secondary batteries near by, and adjoining them are the offices of the Electric Launch and Navigation Company, which has one of the most successful franchises, viz., that of operating the electric launches, that has been obtained within the grounds. Steam, naphtha and electric launches were tested in competition, with the result that the latter were adopted.

The last remaining exhibit in the gallery is that of F. A. Ringler & Co., of electrotyping and galvanoplastic work. Some of the specimens are very fine and come easily within the domain of fine art.

Before leaving the gallery floor every true electrician will step into the offices of the Department of Electricity near by to pay his respects to Prof. Barrett and Dr. Hornsby, who have labored so untiringly and so successfully in behalf of the electrical display.

Descending the stairs just opposite these offices, we commence the examination of the exhibits on the ground floor.

THE MAIN FLOOR.

Leaving the larger exhibits to the last, let us proceed eastward to the east aisle and thence northward.

The first exhibit on our right is that of the C. & C. Motor Company, small only by comparison with a very few of the very largest on this floor. This consists of a large direct connected fan, a hoist, a small Knowles pump—all operated by C. & C. motors; a large motor driving a generator which furnishes the light for the display; a handsome marble switchboard for controlling the circuits to the lamps and numerous other pieces of their own manufacture. Over the switchboard, composed of 275 16-c. p. lamps, is the sign

The C. & C. Electric Motor Company, New York.

In the southeast corner of the building is the Western Electric Company's scenic theatre, where half-hourly many beautiful electrical effects are shown. Some of these are entirely new, or produced in a new way, and all the moods of the weather are shown with an Alpine background. In the storm scene the lightning and rainbow are particularly fine and made more realistic by the fall of genuine wet rain. Admission is free to these exhibitions, and they are generously patronized.

During three afternoons in the week, Tuesdays, Thursdays and Saturdays, the experiment has been tried of giving popular lectures on electrical subjects. These are delivered by electricians of note, and have proved so popular that they will be continued. The scenic theatre has been taken up somewhat out of place, as it properly belongs to the Western Electric Company's exhibit, but it has an individuality of its own, which, together with its position in the line of march, have led us to consider it separately.

Going north on the east aisle we have on the right the Washington Electric Company exhibiting the Sloss electric gas lighter attached to handsome fixtures in a beautiful pavilion. The Wilder Duplex Electric Burglar Alarm and Messenger Company show an extensive line of their goods next, and then comes the exhibit of the Cleveland Electrical Manufacturing Company, consisting of the American watchman's time detector and employés' time recorder.

Taylor, Goodhue & Ames occupy all the remaining space along the wall up to the side door and exhibit Burton heaters in their various applications, Century insulated wire, Acme oil filters, King dynamos, motors of the Wagner Electric Manufacturing Company, of St. Louis, Insullac and Enamelac, etc., etc. Opposite all of these displays or on the left of the aisle is the Western Electric Company.

The Eddy Electric Company occupy the remaining wall space from the door to the toilet room and display a long line of their motors, both bipolar and multipolar. Two pieces are shown in motion, viz., a 50-h. p. bipolar motor driven by a 500-volt current brought from their 1,000-h. p. service plant in Machinery Hall. This operates by belt a 650 light four-pole generator. The most northern portion of this space is fenced off and handsomely furnished as an office.

Just across the aisle to the west is a portion of the display of the Westinghouse Electric and Manufacturing Company.

Following around the aisle, but still hugging the wall, we pass the exhibit of the Excelsior Electric Company on our left. This company occupies a corner of a block otherwise occupied by the General Electric Company. They display fan and other motors, both still and in operation. One type of their motors will attract special attention from the novel construction of the fields, portions of which are hinged so as to open like doors for the removal of the armature when necessary. A large assortment of arc lamps are also displayed here.

Proceeding across the east end of the transept we pass by the east entrance to the building, two stairways leading to the floor above on the right and the alternating current department of the General Electric Company on the left.

Next comes the German exhibit, to the left, but we will visit that later and continue on now up the east aisle again.

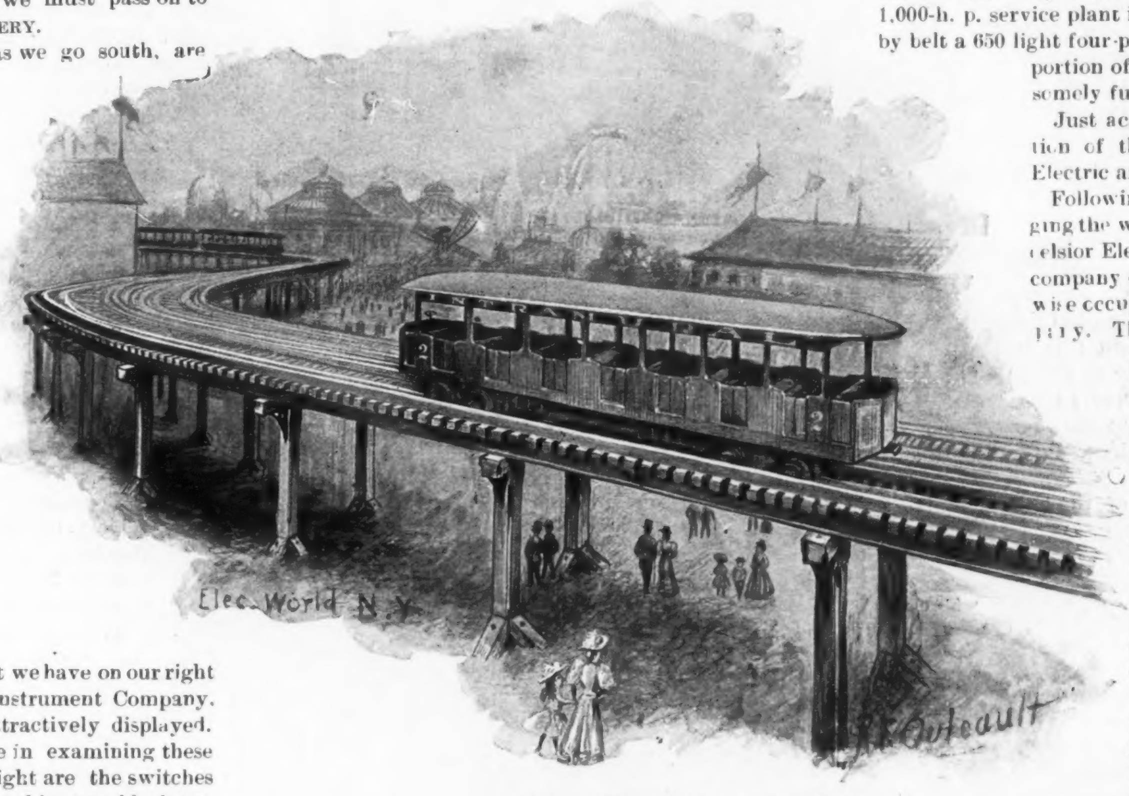
On the right against the wall is one division of the belting exhibit—another portion will be found further along in the northeast bay. This portion comprises the exhibits of Charles A. Schieren, G. Munson Belting Company and Page Belting Company, who have vied with each other in the novel and attractive effects produced by this useful material.

To the left is the Electrical Forging Company, of Boston. This company shows electrical forging machinery in actual operation, also arc welding by the Bernardos process, and that new and intensely interesting process discovered by Hoho & Lagrange, of heating and even melting wrought iron in water. It is stated that by this method a temperature of 8,000 degs. Celsius has been attained. The mechanical importance of this fact will be apparent when it is remembered that this is a degree of heat nearly three times greater than that required to extract iron from the ores, the most refractory of which fuse at about 2,700 degs.

A voltage of about 120 is used and the current varies with the size of the piece to be heated from 20 to 220 ampères. The piece to be heated is grasped by a pair of tongs attached to the negative side of the circuit and when inserted in the water forms the kathode. The anode or positive side is a large lead plate. So rapid and local is the heating that one end of a 3-inch piece of iron may be entirely melted off, and yet the other end remain cool enough to handle.

Full details of this remarkable process will be found in THE ELECTRICAL WORLD for June 10, page 430, and July 15, page 42.

Continuing north on the aisle we pass in succession the Belknap motor exhibit, with its many motors driving fans, coffee mills and a novel color changing sign, a telephone pavilion and a space equipped with a small electric railroad and a waterway and bridge, all provided with overhead trolley wires, but with nothing to indicate their use or the name of the exhibitor. This space was allotted to A. C. Mather, we believe. There are some plants growing



THE INTRA-MURAL RAILWAY.

in the centre of the space and some facetiously inclined person has stuck up a sign "Electrically Grown Plants." These three are on the left.

On the right is the space allotted to A. Groetzinger & Sons, derma-glutine and rawhide pinions, and the General Incandescent Arc Light Company, which is filled with elegant specimens of their arc lamps and fixtures. The most attractive of these is a beautiful six-light chandelier.

To the north of this, and extending partly into the northeast bay, is the very comprehensive display of supplies and apparatus of the E. S. Greeley & Co. Among these, placed upon a handsome plush stand, is the Victor key used by President Cleveland on the opening day to start the great Allis engine in Machinery Hall.

Next, along the curve of the bay, comes the second division of the belting display, consisting of the exhibits of the Jewell Belting Company and the Chicago Belting Company. Both of these are very handsome and complete.

The centre of the circle is occupied by the Union Electric Company storage batteries and motors.

Of the former two kinds are shown, those having a lead positive and a zinc negative, which give an electromotive force of 2½ volts, and those using lead for both positive and negative. Among the motors shown is one for direct currents known as the Main motor, which employs no wires whatever in its movable parts. Electricon anti-friction metal, and the goods of the Fibre Conduit Company, of 45 Broadway, N. Y., are also shown. The Zuckers & Levett Chemical Company occupy the remaining portion of the outer ring of the bay, with a complete plant of electroplating apparatus. This is in actual operation and the visitor may here see the complete process from beginning to end.

The central space within the bay is divided into two, the north half being occupied by slot phonograph cabinets, and the south half by the Japanese display, consisting chiefly of seismographs, pictures of earthquake catastrophes, and wire models showing the paths followed by particles of earth during certain seismic disturbances.

Queen & Co.'s exhibit of electrical testing and other instruments, so fully described in The Electrical World of July 15, is nearly opposite the Japanese display to the southwest.

One of the most interesting of their exhibits is the pair of Hertz mirrors just east of the pavilion. This is one of the only two pair in this country—the other pair having also been made by this firm. Within the pavilion a room has been fitted up as a dark room for photometric and other work requiring darkness.

Passing west across the north end of the hall we have on our left the French exhibit.

THE FRENCH EXHIBIT.

The most conspicuous display at the north end of the building is the lighthouse exhibit of Barbier & Co., and just north of this are small displays by Sautter, Harle & Co., Société Gramme, Maison Breguet and E. Desroziers. Sautter, Harle & Co. show a small marine engine direct connected to a generator and search lights. The Société Gramme makes an exhibit of great historical interest, consisting of the first Gramme dynamo constructed by the inventor himself in 1870, and presented to the Academy of Sciences in 1871, and another, the first Gramme dynamo of the ordinary type, made in 1872. This machine was exhibited at Vienna in 1873; in London, 1875; and in Philadelphia in 1876. There is also shown the improved type of 1893.

The Maison Breguet shows search lights, also a disc armature generator direct connected to a small marine engine. E. Desroziers shows a number of multipolar disc generators, and a number of large photos of other apparatus of extreme interest.

The French Department of Posts and Telegraphs, which is in charge of M. Delatour, who is also one of the representatives of the French government to the Electrical Congress, is particularly fine and complete. It occupies, in addition to a part of the body of the hall, the whole northeast bay. There is not room at this time to give even a catalogue of the exhibits in this department, so numerous are they, and a week or even more may be advantageously spent in examining the apparatus. French taste both in the finish and arrangement of the instruments is everywhere conspicuous, and the number that are entirely new to us is large.

Christofle & Co., galvanoplastic reproduction; Bernard Frères, Leclanché batteries; J. Richard, registering instruments; J. Carpentier and E. Ducretet and L. Lejeune, measuring instruments; Cance, miniature and large arc lamps; Lazare, Weiler & Co., bare copper wires; Menier, insulated wires; C. H. Melde, supplies, and the Maison Labette, electroplating, complete this handsome display.

TESTING ROOMS.

In the northwest corner of the building there have been fitted up for testing purposes two laboratories, one over the other. The lower one is for testing meters, etc., and the upper for testing primary and secondary batteries.

In the southwest corner of the building, fenced off by wire netting, is a small space wherein the life tests of incandescent lamps will be made. On the chart this space has been marked "Kennedy Electric Company."

Passing west we have on the left the Elektron exhibit of motors and electric elevator running to the gallery floor. Turning to the left and going south we have on our left the American Battery Company, whose exhibit consists of storage batteries and a four-wheeled carriage and a chair fitted with these batteries and a motor for electrical propulsion. The Hardtmuth exhibit of carbons is just south of this, and opposite, to our right, is J. L. Wing & Co.'s exhibit of ventilating fans, etc.

Wiles & Scofield are located next on the left. They have a concession for making medals, etc. The Electrical Conduit Company comes next, filling out the space with their well known Johnston iron conduit. Opposite is the Standard Electric Company's display of arc lamp dynamos, arc lamps, hangers, etc.

South of the aisle the space up to the western end of the transept is occupied on the right by a French exhibit of colored prints and electrotypes and the Equitable Dynamo Company, and on the left, or east, is the display of the Thomson Electric Welding Company. Here all the machinery used in this well known process is displayed, together with samples of the work, and small welds are constantly made by an attendant in charge.

GREAT BRITAIN.

Great Britain has not made a large display, but such as it is it will be found between the Thomson Electrical Welding Company on the west, the Westinghouse transmission plant on the east, and a part of the French display on the north. The most notable exhibit is that of the British Postal Telegraph Department, which is very full and seemingly complete, but it lacks that nicety of finish and refinement characteristic of the French display, though it is exceedingly interesting. The very creditable display of

THE BELL TELEPHONE PAVILION.

the General Electric Company, Limited, of London and Manchester, fully described in The Electrical World for July 10, and that of the Homacoustic Apparatus Company, described in the issue of July 17, complete the British exhibit.

Within the space allotted to this country, but not occupied, has been erected a booth to exhibit Meyers' ballot machine. This bears a placard emphasizing the fact that "No electricity is used."

At the west end of the transept are found the two stairways leading up to the floor above, and behind one of these is a parcel-check room, where parcels may be checked for 10 cents apiece.

In front of this same stairway is a branch exhibit of the electrical engraving process, located in the southwest gallery, and an exhibit of Paillard's non-magnetic watches.

Going still to the south, we pass on the left the fine exhibit of the Fort Wayne Electric Company. In this are shown the Wood arc and incandescent generators and the new Wood alternator, which is attracting great attention at present. This latter has an ironclad armature, is slow speed and has a remarkable weight efficiency. Very little wire is used on the armature, and it is claimed that a greater induction per unit of armature wire is obtained here than ever known before. On the right is the extensive display of motors and generators of the Mather Electric Company and on the west wall back of it is the display of the new Novak lamp. This lamp is also an out growth of the lamp litigation, and, as it is a gas lamp, is thought not to infringe the Edison patents. The remarkable claim is made for this lamp that it maintains its initial candle power and efficiency throughout its life.

Passing over to the west aisle we pass on our right the exhibit of the Standard Underground Cable Company and the Hanson & Van Winkle Company. The former show a large line of their celebrated insulated wires and cables, and the latter everything connected with the electroplater's art, including specimens of the work done. Electroplating generators of all sizes are shown, and the historical magnets first used for this work is part of the exhibit.

Moving to the east at the south end of the building we have on our right the lamp-testing room before referred to, and next to this the beautiful pavilion and display of the Jenney Electric Motor Company.

Within the railing, besides many other motors, there is one of 35 h. p. directly connected to a 100-volt generator of 500-light capacity. The current operating this motor is of 500 volts. A small fan is also operated here on the end of a long flexible shaft.

THE AMERICAN BELL TELEPHONE COMPANY.

The American Bell Telephone Company's pavilion, which is 103 feet long by 67 feet in width, stands directly opposite the south entrance to the Electricity Building, and forms the gateway, at it were, to the main floor. It is classic in design throughout, the front being copied after the Erectheum at Athens. Through a portico of Ionic columns the visitor enters an open court, which is surrounded on all sides by peristyles of Ionic columns with dome, to the inner rooms. At the rear of this open court or atrium is a large dome temple sufficient in size to accommodate nearly 100 persons. The rotunda in the centre is 24 feet in diameter and is surrounded by an ornamental tablature, the drum of the dome and by the dome. The exit from the building on the north side, looking out upon the Westinghouse street railway exhibit and facing the great Edison Tower of Light, is through a peristyle and portico similar to the entrance at the opposite end.

On the left of this exit will be found the receiving instrument of the radiophone, whose transmitter is in the southwest gallery. To the right is a cabinet in which is a telephone instrument connected by direct wires with New York, which is open to the public between three and five o'clock in the afternoon, to test the long-distance possibilities of communication. In the east peristyle are three double show-cases containing a complete historical exhibit, illustrating the growth and improvement of telephone instruments (transmitters and receivers) from the earliest to the last. Here will be found what remains of Bell's telephone of 1875, the first electric telephone that ever transmitted speech, and a reproduction showing what it was is placed by its side. Here also are the Prof. Bell's Centennial instruments. They are the identical telephones which were used at the Centennial in 1876, when Prof. Bell, in the presence of Sir Wm. Thomson, Prof. Henry, Dom Pedro and others, gave the first public exhibition of the telephone.

In the west peristyle is the latest type of telephone switchboard, to which are connected all the telephone subscribers within the World's Fair grounds.

This is a very busy place. Calls are coming in rapidly, and the operators find constant occupation in giving the desired connections. Attendants are present to explain every detail of the operations involved.

At the south end of the peristyle is an illuminated manhole covered with a grating. Looking down into this one can see the underground cables containing fifty pairs of wires, which radiate from this building to subscribers in all directions.

Within the temple, suspended from the ceiling, is a telephone receiver fitted with intensifying cones connected by wires with Chicago. At the other end on special occasions concerts are given, which can be very distinctly heard in all parts of the temple by those assembled.

Upon either side of the temple, hanging upon hooks on the wall, are a number of small telephones. These have been connected with the German Village in the Plaisance and other points, whence music is transmitted at stated times, usually throughout the afternoon and evenings, which may be distinctly heard by holding these small telephones to the ear. The walls are hung profusely with pictures and diagrams explanatory of telephonic instruments, and in this way the exhibit has an educational value of the first importance.

THE WESTERN ELECTRIC COMPANY.

Supplementary to the last exhibit, in an educational sense, may be considered the telephone and switchboard exhibit of the Western Electric Company, whose display lies directly to the east. In the southeast corner of their space are a series of telephone switchboards, one for each year since 1883, each being the type for that year. On the back of each are a number of blueprints showing the departures from that type during that year.

Near by are a lot of showcases containing all of the instruments used in telephony, both assembled and in separate parts. Thus the magneto and bell, with its 330 parts, the telephone proper, with its 28 parts, and the Blake transmitter, with its 88 parts, are shown beneath glass. There are also a lot of drawers provided in which each of the parts of the various apparatus are accessible for handling. The educational feature of this part of the display is a most admirable one.

Close at hand are Patterson cables, wires, etc., and in one and another part of the exhibit are shown everything manufactured by this extensive concern. Among the displays of Patterson cables are some containing 150 pairs of conductors for telephone lines.

In the very centre of the space is the spectacular piece of the show—the lightning tower, with its 2,632 lamps, and the two zones of light chasing each other up the column, spreading out along the four streamers and disappearing in the revolving globes and pendants.

The writing machines, of which there are three, are constant sources of amusement and wonder to the visitors. But the handsomest feature of the display is the Egyptian temple, with its soft illumination within, and its unique decoration without.

Attention is called to the figures and symbols. The former are true copies of Egyptian decorative designs, but the figures are put to new work. It will be seen that each individual or group is engaged in some occupation pertaining to the electrical business. What at first sight appear like meaningless hieroglyphs are seen on close examination to be electrical devices or parts of such manufactured by the Western Electric Company. This display was fully described and elaborately illustrated in The Electrical World for June 24.

THE GENERAL ELECTRIC COMPANY.

The exhibit of the General Electric Company in the Electricity Building occupies the four centre spaces and the adjoining spaces under the galleries. Commencing at the south centre space, one sees to the right a line of Thomson-Houston motors with automatic rheostats. One of these motors is arranged with Prony brake, so as to show by overload the action of this automatic rheostat as an overload switch. Its action can also be shown by throwing the switch, and thus depriving the motor of its supply of current. To the left of the space is a line of Edison motors, these being supplied with very compact and attractive switchboards, the starting box, amperemeter, voltmeter and circuit-closing switch being all attractively and substantially combined in a single fireproof structure, and supported on a tripod at convenient height for handling. Between the two lines of motors are the special motor applications shown by the General Electric Company, including factory trucks, ventilating fans, motors as supplied for the electric launches, electric drill with flexible shaft and electric derrick. The derrick is of five tons capacity and provided with a lifting magnet of capacity of 2,000 pounds. The latter is actuated by a snap switch; the current being led to it by a flexible cord, the same as the incandescent lamp. To show the force of this magnet there has been constructed a platform on which can be gathered 14 to 16 people of average weight. Placing the magnet upon its keeper, which is also fastened to the platform, and, turning on the current serves to energize the magnet to such an extent that it is very easy for the derrick to lift the entire platform and its load.

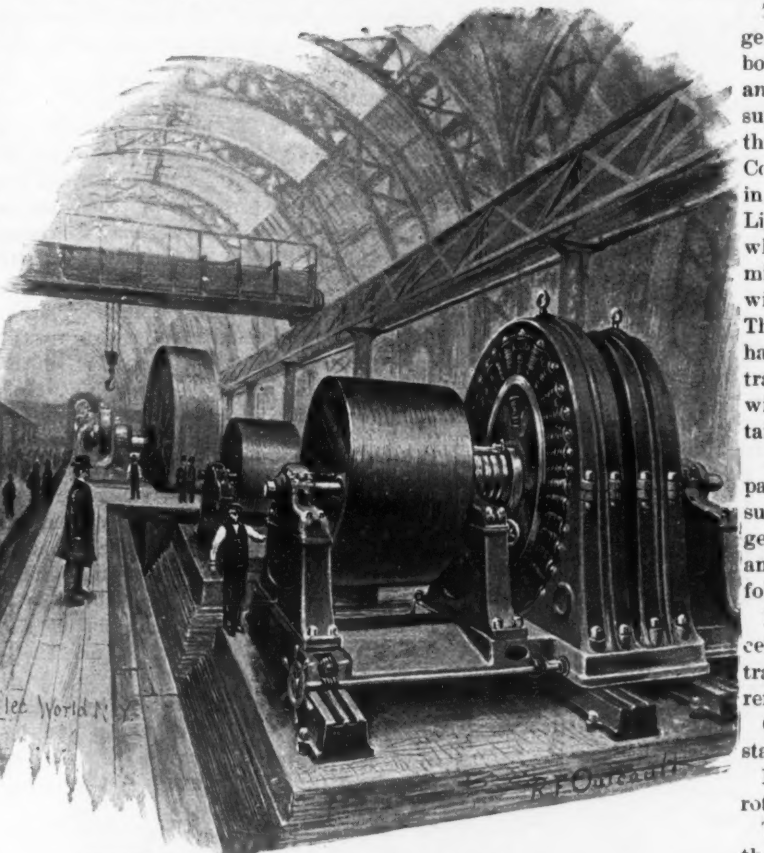
Beyond the motor exhibit is the railway exhibit of the company, consisting of its multipolar ironclad railway generators of the belted types, the new panel switchboards devised by the General Electric Company, and several trucks carrying the most modern motors. Among these is the new type, G. E. 8 motor, on a Bemis truck, the type W. P. 30 on a Taylor truck with Genett airbrake, the type W. P. 50 on a Robinson radial truck, and the type L. W. P. 20, as used on the Intramural Railway, on a Jackson & Sharpe truck with the Griffin Car Wheel Company's wheel. The latter truck is shown complete, with its airbrake equipment, as supplied on the Intramural Railway by the New York Air-Brake Company. On the showboard covering the reverse of the switchboard is shown a diagram of car wiring as practiced by the General Electric Company in its series parallel system.

In the east centre space is the merchant marine exhibit of the General Electric Company, including direct connected generator, 4-winch hoist, search light projectors and all the electric light fittings peculiar to merchant marine or man-of-war service. The Stanley-Kelley two-phase system with general electric generator specially designed for this service is also here shown, as well as alternators of direct and belt-driven types. Toward the centre of the building in this space is shown a collection of models and special apparatus, designed by Prof. Elihu Thomson, electrician of the General Electric Company.

In the north centre space is collected the Edisonia of the company. The Jumbo machine, after 11 years of continuous service, was taken out of service and kindly loaned to the General Electric Company by the New York Illuminating Company for this display. To the north of the Jumbo is a complete display of the three-wire system with all the material needed therefor. Adjoining this is a set of machines supplying current for the quadruplex telegraph service of the Western Union and Postal Telegraph companies, reaching out from the World's Fair to all the various points accessible without retransfer.

The lamp exhibit of the Edison lamp factory is the first complete commercial exhibit ever attempted of the incandescent lamp. It is remarkable in showing the number of varieties of lamps that are in commercial use at the present day, there being 2,500 commercial lamps in the exhibit, no two of which are alike. The space at the north end contains as an exhibit an enormous fan studded with over 1,300 incandescent lamps of one candle power each, the whole arranged in such a manner that by a commutator the fan can be made to open and shut, the lamps marking each rib together with the lamps involved in the ornamentation of the web of the fan lighting in succession, the lighting extending in either direction from a vertical line until the entire fan is displayed to view. The reverse motion of the commutator closes the fan, the lights on radial lines disappearing first, commencing at the outer edges on the horizontal lines and finally on the centre vertical radius.

In the west centre space is the power transmission and mining exhibit of the General Electric Company. In the power transmission department is shown in full the three-phase system of power transmission, including a very interesting series of transformations of energy. In the centre of the exhibit stands a deep mine triplex pump of 500 gallons capacity for a lift of 650 feet, moved by a 100-h. p. 220-volt electric motor. The motor derives its energy through the transformations of fuel, boiler pressure, engine and dynamo with transmission from Machinery Hall on the Edison three-wire system. The triplex pump delivers the water under the head as described against the Pelton water wheel, which at 750 revolutions delivers its power to the armature of a 35-kw. three-phase electric generator, the armature of the generator being on the same shaft as the paddles of the Pelton wheel. From the three-phase generator the current is conducted to a set of step-up transformers having ratio of 20 to 1 and transmitted across to the mining space on three No. 18 wires, where by means of step-down transformers the potential is reduced to 110 volts. At this potential from a distributing switchboard the current is used to light 500 incandescent lamps, arranged equally on each of the three legs of the three-phase circuit to three series of arc lamps, arranged two in series, with resistance across each of the three legs of the three-phase circuit, and to a series of three phase motors from three to 15 kw. capacity. In addition to this system is shown



WESTINGHOUSE 10,000-LIGHT DYNAMO.

a synchronizing system, the alternating current generator driven by a direct current motor being on one side of the exhibit space, and the alternating current motor on the other side of the exhibit space. The direct current motor driving the alternating current generator is worthy of especial notice, as it is in fact a motor transformer having on one side a direct current commutator and on the other side the three-phase commutator, and is used as either a direct current or three-phase motor or as a motor transformer, at the will of the operator.

In the rear of this exhibit on the west side of the building, but in the same exhibit space, is shown an amount of mining apparatus, including locomotives from 20 h. p. to 80 h. p., from 18-inch to 36-inch gauge, pumps of various styles and capacities, hoists, electric air compressors and reciprocating and prospecting drills.

The central space of the building is given up to a tribute to the Edison lamp. The tall shaft, extending almost to the roof, with a colonnade about the base, is here modeled after the German Tower of Victory. The lower space about the colonnade is given to the exhibit of the Phœnix Glass Company, where they show exclusively crystal and glassware for electrical purposes. The entire lighting was designed and installed by the General Electric Company, the Phœnix Glass Company furnishing all glassware and fixtures. Above, the cornice stunting the dome, between the exterior of the colonnade and the central shaft, are ribs of 5-c. p. incandescent lamps in various colors. Arising from the centre of this dome, 10 feet in diameter at the base, is the central shaft, studded in vertical and zigzag lines, with thousands of incandescent lamps, that, in connection with commutating switches, located in the tower, can be made to flash and reflash in a manner that holds all spectators spellbound. Around the cap in incandescent lights, on each of the four sides, are the words "Edison Light." Above the capital surmounting the shaft is a mammoth incandescent light, made of thousands of pieces of crystal, illuminate within by numbers or small-sized incandescent lamps, bringing out a play of prismatic colors that is exceedingly attractive. Surmounting the shaft and next to the ceiling, in miniature incandescent lamps, is the name "General Electric Company." By means of a reactive coil this can be dimmed one moment and the next moment caused to blaze out at full candle power.

THE WESTINGHOUSE ELECTRIC TRANSMISSION OF POWER.

A complete plant illustrating electric transmission of power, as accomplished by the Tesla polyphase alternating current system, is shown in Section J, Space 2, north centre of Electricity Building. This plant comprises a generating station, a high-tension transmission circuit, and a receiving and distributing station.

Generating Station (north of pavilion).—This station comprises the following:

One 500-h.p., two-phase alternating current generator.

One 5-h. p. direct current exciter.

One complete marble switchboard.

Raising or step-up transformers which receive alternating current at moderate potential from a two-phase generator and deliver alternating current at high potential to a high tension circuit.

In practice the generator and exciter would of course be driven by water power, but, since no such power is here available, the generator belt is driven by a 500-h. p. Tesla polyphase motor of the rotating field type, while the exciter is direct driven by a 5-h. p. motor of the same type. Both of these motors are operated by current from the ordinary lighting circuits of the Exposition, which are supplied from the large Westinghouse two-phase alternators in Machinery Hall.

Transmission Circuit.—The switchboard at the generating station is connected with the switchboard at the receiving or distributing station by an overhead four-wire circuit. The insulators supporting this circuit are of the type designed by the Westinghouse Electric and Manufacturing Company, and now in successful commercial use in the installation constructed for the San Antonio Light and Power Company, of Pomona, Cal., where energy at 10,000 volts potential is transmitted by an overhead circuit of bare copper wire, No. 7 B. & S. gauge, a distance of 28 miles. This is the greatest distance over which energy has hitherto been economically and successfully transmitted, but much greater distances are within the range of commercially successful attainment.

Receiving Station (south of pavilion).—The apparatus at the receiving station, which we may suppose to be located many miles from the generating station, with which it is connected by an overhead transmission circuit, comprises the following:

Reducing or step-down transformers which receive high potential alternating current from the transmission circuit and deliver alternating current at moderate potential to various local circuits.

Complete marble switchboard for receiving station.

Five hundred h. p., two-phase Tesla motor and rotary transformer.

This machine receives alternating current from the reducing or step-down transformers, and its function is twofold.

First, it operates as a motor to drive: *a*, a Worthington pump; *b*, a 40-light Westinghouse alternating current arc light dynamo.

Second, it delivers direct current at a potential of 500 volts used for operating: *a*, two 30-h. p. Westinghouse street railway motors, single reduction type, mounted upon a standard Dorner & Dutton truck; *b*, a 60-h. p. direct current motor, driving an Ingersoll-Sergeant air compressor; *c*, direct current constant potential arc lamps; 60 h. p., two-phase motor and rotary transformer.

This machine is supplied with two-phase alternating current from the reducing or step-down transformers, and may be used as a motor or as a rotary transformer or both. As a rotary transformer, it delivers direct current at 50 volts potential, adapted to electrolytic work, charging of storage batteries, operation of search lights, etc.; 60 h. p. two-phase Tesla motor—synchronous type.

This motor is direct coupled to a 45-kilowatt Westinghouse slow-speed alternator of the constant potential type, used for incandescent lighting.

This system, while it permits the use of very high potential alternating current required for transmission over great distances, delivers both alternating and direct current at any potential desired. It is therefore adapted to any kind of service to which electricity is applicable, and, as here illustrated, both alternating and direct current for any kind of lighting or power service, or for electrolytic work, may be obtained from a single generator and a single transmission circuit.

The application of this system to mining operations is of special interest and importance. It will be noted that the direct current from the rotary transformers is excellently adapted to haulage and hoisting purposes, etc., while the air compressor, used to operate standard pneumatic drills, may be driven, as in this instance, by a direct current motor, supplied from the rotary transformer, or by a

Tesla polyphase motor, supplied with alternating current from the reducing transformers.

STREET RAILWAY APPARATUS.

The exhibit of apparatus for the operation of street railways by electricity, shown in Electricity Building, Section H, Space 1, south of the centre of the building, comprises the following:

One 270-h. p. multipolar generator direct, driven by Westinghouse compound engine.

One 400 h. p. multipolar generator, belt-driven type.

Westinghouse street railway motors, single reduction type, 20, 25 and 30-h. p. capacity.

One Brownell 20-foot car, equipped with two 30-h. p. Westinghouse motors, single reduction type, series multiple controller, etc., etc.

One Stevenson 16-foot car, equipped with two 30-h. p. Westinghouse motors, single reduction type, series multiple controller, etc., etc.

Complete line of switches.

Complete line of ammeters and voltmeters.

Complete line of Westinghouse automatic circuit breakers.

Lightning arresters.

Switchboard fittings and connections.

Motor details illustrating construction.

APPARATUS FOR ARC AND INCANDESCENT LIGHTING.

Spaces 1 and 2, Section B, Electricity Building, contain apparatus for arc and incandescent lighting. These exhibits comprise the following:

Standard Westinghouse alternators of various sizes, including a field casting of a 450-k. w. standard belt driven alternator, showing Westinghouse method of casting laminated poles into cast iron frame.

Standard Westinghouse converters and transformers.

Special converters equipped with non-arcing metal lightning arresters.

Direct current motors and generators of the horizontal type.

Direct current generators and motors of the "letter" type.

Direct current generators of the multipolar type.

Direct current motors of the Manchester type.

Alternating current arc light dynamos.

Shallenberger alternating current meters complete and in operation, also parts illustrating construction.

Wurts non-arcing metal lightning arresters for alternating current circuits, in operation.

Lightning arresters of various types for direct current circuits.

Complete line of switches for alternating current work.

Complete line of switches for direct current work.

Complete line of ammeters and voltmeters for alternating currents.

Complete line of ammeters and voltmeters for direct currents.

In Section B 1, opposite the space occupied by the Railway exhibit, a dark room is erected for special exhibits of high potential and high frequency phenomena. Exhibitions of high potential discharges are given daily. The space adjacent to this room contains an exhibit of some of the early motors designed by Mr. Nikola Tesla, and also apparatus for illustrating the remarkable results obtained by him in the use of high frequency alternating currents.

THE GERMAN EXHIBIT.

This lies to the east of the Edison lamp exhibit, the Westinghouse transmission of power and the French lighthouse exhibits, and directly beneath the Northeast Gallery. There is much here of interest to American electricians, for which we scarcely have space even for a complete catalogue.

The southernmost exhibit is that of Felten & Guilleaume, of Muhlheim. This firm displays wire goods of all kinds, both insulated and bare, and such as is used not only for electrical purpose, but for ship rigging, running gear, bridge and tramway purposes and all other uses to which wires and wire cables may be put. These are very tastefully arranged in pyramids and in glass cases.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.

This lies directly north, and is especially interesting because this firm constructed and erected the plant for the now famous Lauffen experiment, in which some 300 h. p. were electrically transmitted at 30,000 volts from the Falls of the Neckar at Lauffen to the Frankfort Exposition. This experiment brought the three-phase system most prominently before the public, and in this exhibit are shown photographs of the stations at Lauffen and at Frankfort, and a number of three-phase motors very similar to those used in the experiment. None of those shown are exact duplicates, however, but embody improvements which were suggested by that experiment and later experience. Instruments of precision are shown in abundance, and a series of electric clocks, which may be inserted like lamps in an ordinary lamp circuit and automatically set to the right time from the central station by simply lowering the electromotive force of the generators from six to ten volts. The street railway supplies, differing somewhat in pattern and in other respects from those used in this country, are exhibited. A large direct current motor belted to an alternating current generator is shown in operation. A novel feature of this motor is what is called the "polar pring," which is a cylinder of soft iron, about an inch thick, enveloping the armature and connecting the four pole pieces. This has never been used in this country, but is thought to have advantages in the prevention of sparking at the commutator, for which purpose it is applied, which more than compensate for the short circuiting, which it must inevitably produce. A starting switch for this motor will also be noticed that is something entirely new to us, which consists of a couple of cells partially filled with a solution of soda, which are connected in series by a ∩-shaped metal piece, which is dipped into the liquid when it is desired to close the circuit. In the operation of closing, the tips of the two legs first touch the two surfaces of the liquid, and as they are further immersed offer less and less resistance until they are immersed to the fullest extent, when they themselves and the cells are short-circuited by a metallic bar resting on the two terminals of the circuit. In shutting off the motor this short circuit is first broken, and as the fork is lifted out of the liquid the resistance to the current is gradually increased until it is finally made infinite by the lifting of the forks entirely above the surface.

A large three-phase motor directly coupled by means of a flexible coupling operates a four-poled generator with a capacity of 500 amperes. Special attention is called to this flexible coupling, which is also new to Americans.

HARTMANN & BRAUN.

Crossing over an east and west aisle is the display of Hartmann & Braun, of Frankfort, who have constructed a handsome pavilion, within which are shown a very large and interesting collection of electric measuring instruments of all kinds. This display is worthy of close study.

SCHUCKERT & CO., OF NURNBERG,

adjoin Hartmann & Braun on the north. They display chiefly search lights and the apparatus required for their operation. The reflectors used by this company are a departure from the practice here in this country, and are said to possess certain merits over the metallic reflectors with which we are more familiar.

SIEMENS & HALSKE.

Here are displayed the three-phase motors and transformers of their make. Of the latter there are two of 50,000 watts capacity each, one intended for outside use and the other for inside use, the latter being a step-down transformer, and the former a step-up transformer. In these, air alone is used as insulation. In the centre of the floor is a street railway truck equipped with a three-phase motor with external fields. This is absolutely weather and dust proof. When the star connection is made for the three wires this motor has a capacity of 20 h. p. When the triangular connection is made the capacity is 60 h. p. It is geared to one axle by means of a worm gear, and is intended for 600-volt circuits. There is also shown a large three-phase 60-h. p. motor. This is provided with a novel starting device, which consists of a ring fixed on the armature shaft and revolving with the armature, which by conical bearings and screwing in or out either entirely breaks the armature circuits or gradually throws them together. An instrument for measuring the velocity of rifle and cannon balls, capable of measuring within .000002 second; telephones and microphones, electricity meters and other measuring instruments, are also shown.

Adjoining this booth are storage batteries by Charles Pollak, and other goods of interest to electricians.

The last booth assigned to Germany is occupied by Schomberg & Sohne, of Berlin, insulators and porcelain ware, and general supplies.

Stockard & Co., Leipsic-Plagwitz, supplies.

J. Berliner, Hanover, telephones.

Seitz & Linhart, Aschaffenburg.

Otto Zwarg, Freiberg in Sachsen lightning rods.

Körting & Matthieson, Leipsic; arc lamps.

Wilhelm Minner, Arnstadt; graphite and some other smaller exhibits.

THE BRUSH, SHORT AND SPERRY EXHIBITS.

In the southwest corner of the building, and directly west of the Bell Telephone pavilion, are the three exhibits of the Brush, Short and Sperry companies, which show a profusion of machinery of these well known types attractively distributed and arranged for inspection. At the south end of the Brush space stands a handsome Corinthian temple, with dome-like roof handsomely frescoed within. This temple is used for a rustic place for visitors, and the opportunity has been taken advantage of to show the beautiful lighting effects obtained by concealed lights. A circle of these surrounding the base of the dome and concealed from view illuminate beautifully the clouds and sky, which is the theme of the frescoing. The illumination, therefore, is entirely by reflected light, and the effect is very soft and refined and pleasing.

Surrounding this temple on all sides, and covering the space to the north, are exhibited machines of the Brush type, both for arc and direct current incandescent lighting, and alternate current generators, in all sizes from the smallest made up to the largest.

The Short exhibit is essentially electric railway generators and motors. The most striking of these is a 450-h. p., 50 inch generator of a new type. This machine at a speed of 300 revolutions has a capacity of 600 ampères. The original gearless motor, followed by two improved forms, and finally by that latest produced, together with single reduction motors, is shown.

In the immediate vicinity is the carbon exhibit, in which are shown carbons of the Brush manufacture of all sizes.

The Sperry exhibit, directly north of this, shows the singlemotor equipment with a flexible connection for street railway trucks.

A New Incandescent Lamp.

We illustrate below a new incandescent lamp just placed on the market by the Pennsylvania Electric Engineering Company, Penn Mutual Building, Philadelphia, Pa.

It is claimed that this lamp does not infringe any existing patents, for the reason that in the recent decision handed down by Judge Wallace in the case of the Edison

THE "MAGGIE MURPHY" LAMP.

Company versus the Sawyer-Man Company the combination sustained was that of a carbon, filamentary or threadlike in size, and properly carbonized, in a receiver made entirely of glass from which the air is exhausted to such an extent that disintegration of the carbon due to the action of the surrounding air, or any other causes, is so far reduced as to leave the carbon perfectly stable.

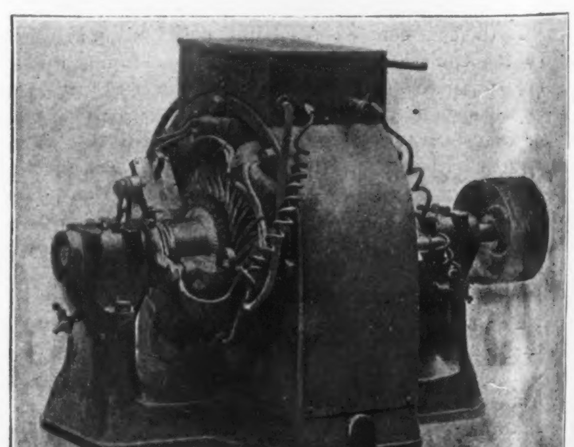
In this new lamp the receiver is not made entirely of glass, nor do the conductors pass through the glass, from which it follows, it is claimed, that the lamp does not infringe any existing patent, and is sustained by some 18 patents of its own.

The lamp is unique and original in construction. As will be seen by the cut, there is a glass cement stopper inserted in the base of the lamp with a pair of iron conductors passing through the same to which the filament is connected.

The Pensylvania Electric Engineering Company has given the name of "Maggie Murphy" to this new lamp, and can now furnish it in any quantity.

A New Alternating Motor.

In our issue of March 18, 1893, we illustrated the early type of Dahl alternating current synchronous motors, which are made self-starting and self-exciting. We illustrate in this issue the new type of machine built by



A NEW ALTERNATING MOTOR.

the Dahl Electric Company, which has radial poles instead of groups of horseshoe magnets, as in the early machines. These motors, it is stated, are of very high efficiency, and careful tests made with Weston instruments show that the 3-h. p. machines have an efficiency of over 85 per cent. under a brake test at normal capacity, the 6 and 10-h. p. sizes showing an efficiency exceeding 90 per cent., which, compared with tests made on other alternating current motors, is considered remarkable. These machines have been in use for quite a little time, and are proving, it is stated, very satisfactory in many different branches of industry where they have found application. The Dahl Electric Company is now at work on a 2-h. p. size, completing their line of sizes, so as to make the following list of machines: 1 h. p., which runs at about 2,500 revolutions on the usual systems, but is adapted for systems of lower frequency, as found in various parts of this country and Europe; the 2-h. p. size runs at the same speed, and the 3-h. p. machines run at 1,875; the 6-h. p. machines run at 1,500 revolutions, and the 10-h. p. size at 1,500 revolutions, these speeds, of course, varying with the number of alternations, depending upon the systems with which they are connected.

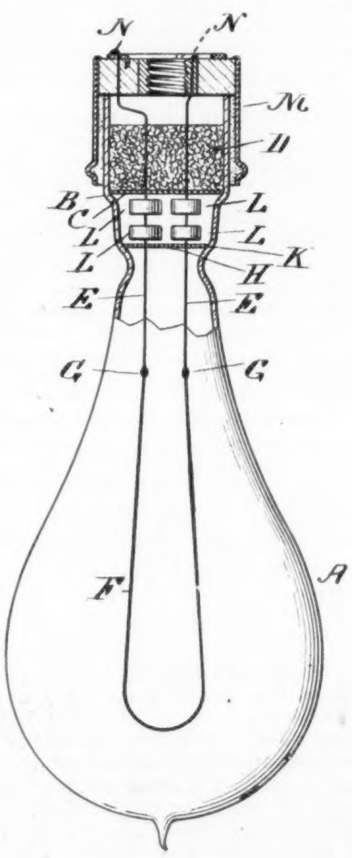
The power of the motor also varies, depending upon the speed. There is, however, sufficient surplus capacity to admit of the machines developing their full rated horse power, even on frequencies as low as 60 to 80 complete periods per second.

It is claimed that the efficiency of these alternating current power motors equals that of many direct current motors, and it is not exceeded by any at the present time.

The New Beacon Lamp.

The diagram shows the general construction of the "New Beacon" lamp, manufactured by the Beacon Vacuum Pump and Electrical Company, Boston, Mass.

The glass globe of the lamp A is provided with a shoulder at B, upon which rests a thin disc of mica, C. The disc serves as a support for a body of cement D, the composition of which is not disclosed, which is poured, in a fused state, upon it, and completely fills the upper part of the neck of the lamp. This cement is of a novel composition, and is not only absolutely impervious to air itself, but makes an equally airtight union or joint with the glass surface of the lamp neck. It is able to withstand the temperature to which it is subjected in the operating lamp without leaking or giving off any gases or vapor whatsoever. The leading-in wires E, E, which are of iron throughout, pass through this cement and through the mica disc C, but nowhere touching the glass of the inclosing globe, and are connected with the filament or burner F at C C. A second disc of mica H is located within the neck of the lamp globe and rests upon the shoulder K. The disc H acts as a reflector and



The New Beacon Lamp.

throws back the heat of the filament, thereby keeping the cement plug from being affected.

Upon the leading-in wires between the two mica discs are placed small bodies of metal, L, L, L, L, called radiators. They are so called because they take up the heat of the lading-in wires and disperse it by radiation, preventing it from being carried into the cement plug. They are very neat and effective devices for the purpose which they accomplish.

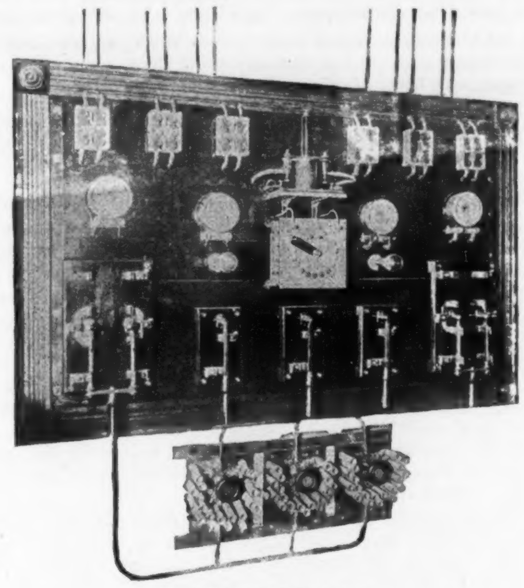
The lamp neck is surmounted by a cap or base M of the ordinary kind, fastened in place by plaster of paris, and to which the leading-in wires are attached by soldering at N H.

While the lamp is burning, the cap and socket are nearly as cool as when it is not in operation, a phenomenon, it is claimed, not known in other lamps, and the candle power holds up in the same remarkable manner as it did in the old "Beacon" lamp.

The "New Beacon" lamp is the invention of Wm. E. Nickerson and Edw. E. Cary, the former the mechanical and chemical expert, and the latter the electrical expert, of the Beacon company. The company has acquired from the inventors the control of the patent rights, which are said to be very comprehensive.

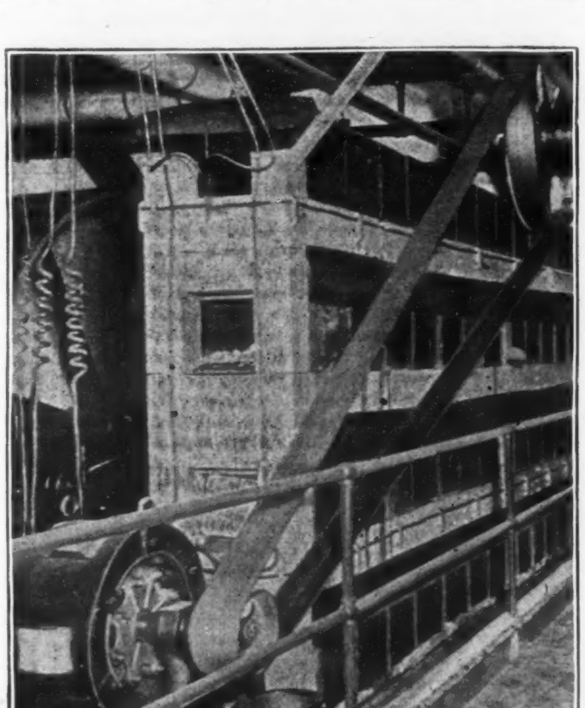
A Storage Battery Plant.

The Franklin Electric Company, of New York, has recently completed what is probably one of the largest storage battery installations in the East, being located



The Switch-board.

at the large print works of Worthen & Aldrich, at Passaic, N. J. The equipment consists of 60 Franklin cells, each having capacity of 1,000 ampere-hours. These cells measure 10 by 12 by 24 inches, and are placed in a rack. The solution is covered with a preparation of oil to prevent fuming (see Fig. 1). The cells were specially manufactured by the Newton Rubber Company, of Boston, Mass., and are constructed to maintain 200 16-c. p. incandescent lamps and eight 2,000-c. p. arc lights, and which have been run continually since the formal acceptance of the plant on April 1. The battery is of the Plante type, has no pasted or applied oxides, and, therefore, it is claimed, does not infringe upon the Brush patents. The mechanical construction is such as to avoid all liability of the plates buckling or short-circuiting and are charged by a Riker multipolar dynamo



The Dynamo and Motor.

having a capacity of 150 volts and 80 amperes, which is run directly from the main line of shafting, passing through the battery room.

A very complete switchboard was furnished by the Franklin Electric Company of special design (see Fig. 2), being so arranged that the batteries or dynamo, or both, can be thrown on to the house circuit; there is a separate line to each of the three floors in the factory. The meters used are magnetic vane meters manufactured by Queen & Co., those shown in the centre of the cut being in circuit with the storage batteries, while those on the outer edge are in circuit with the dynamo.

A cut-out governed by the field of the dynamo automatically connects the battery with the dynamo when the E. M. F. is sufficient for charging, and also automatically breaks the circuit when the E. M. F. of the dynamo falls below the charging point. This switch is an invention of F. K. Irving, electrical engineer of the Franklin Company, and was made by the E. S. Greeley and Company.

This plant was designed by F. K. Irving, electrical engineer of this company, and installed under his supervision.

NEW INCORPORATIONS.

THE ELECTRIC COMPANY, New York, capital stock $1,000, has been formed for a general electrical business. Alfred Knisber, Edward Ayres, New York City, and Samuel Sloan, Brooklyn, N. Y., are the interested parties.

THE ST. CHARLES LIGHT AND FUEL COMPANY, St. Charles, Mo., capital stock $20,000, has been formed to supply electric lights and gas. J. Dell, G. R. Blackford and J. F. Wash, St. Louis, Mo., are the incorporators.

THE GRAY ELECTRICAL TRANSIT COMPANY, Passaic, N. J., capital stock $72,000, has been formed to perfect electrical, mechanical and chemical appliances of all descriptions. R. Murray, N. Y. City; H. F. Gray, E. Kellogg Rose and F. A. Scheffler, Passaic, are the incorporators.

THE WILCOX ELECTRIC COMPANY, Newark, N. J., capital stock, $150,000, has been formed to deal in electrical patents and patent rights. The promoters are: T. B. Wilcox, H. Wilcox, E. R. Dimmick, T. P. Huffman, Newark, N. J.; W. Gibson, W. Bishop, C. B. Peet, W. B. Smith, New York City; and J. W. Hinkley, Poukhkeepsie, N. Y.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-176 Times Building, New York, August 18, 1893.

MR. SAMUEL D. MOTT, of Passaic, N. J., left for the White City on Wednesday of last week.

MR. MORRIS MEAD, city electrician, Pittsburgh, Pa., was calling on friends in New York on Monday of this week.

MR. ELIAS E. RIES, of the Ries Electric Specialty Company, Baltimore, Md., was in the city Tuesday calling on the trade.

MR. WILLIAM S. BARTHOLOMEW, of Bartholomew, Stow & Co., Chicago, exclusive selling agents of the Nutting arc lamp, was in New York for a few days last week.

MESSRS. WM. C. CALLMANN & CO., 136 Liberty Street, agents for the Phoenix incandescent and the Kester arc lamp, have opened a branch office at 679 Broad street, Newark, N. J.

MR. DAVE CHALMERS, of the A. B. C. Co., is rapidly recovering from the shock attendant upon his very narrow escape from being overturned while driving a frisky horse in the country recently.

MESSRS. FRADY & RADWAY have opened offices at 136 Liberty street, where they will handle the Nutting arc lamps, McNutt incandescent lamps, "Iron Clad" rheostats, "Iron Clad" starting boxes, and electrical supplies.

MR. W. C. BRYANT, of the Bryant Electric Company, Bridgeport, Conn., was in the city Tuesday, and stated that his factory will resume operations again Monday next, having been working on short time for a few weeks past for the purpose of making necessary repairs.

MR. HENRY G. ISSERTEL, of the A. B. C. Co., is absent from the city on an extended Western trip. He was heard from on Tuesday of this week from Ohio, his letter containing several large orders for the A. B. C. Co. and a very favorable report of the state of trade in the section which he is visiting.

THE MANHATTAN ELECTRIC LIGHT COMPANY, New York, has brought suit against the city, claiming damages to the amount of $56,571, on the ground that property owned by their clients, consisting principally of wire lines for lights, had been destroyed by employees of the Public Works Department, in 1889 and 1890, and there was also a consequent large loss of rentals.

THE IMPERIAL MANUFACTURING COMPANY, 323 Washington street, New York, reports a large demand for the cut-outs and pole indicators which this company has recently placed on the market. Arrangements have been made with several large supply houses for handling these cut-outs, which are evidently receiving a great demand from the trade, although only placed before the trade a short time since.

MR. J. P. HALL, electrical contractor, 143 Liberty street, New York, has recently closed several important contracts, among which are the following: The Smith & McMarron apartment house, Eighty-sixth street and Madison avenue, an 800-light plant, Waddell-Entz apparatus, to be wired with Grimshaw wire, and a plant for Henry Sanford's residence, Bridgeport, Conn. Mr. Hall has also entirely overhauled the electric plant at Glen Island and placed the same in first-class running order.

Mr. L. D. HILLES, of Bagnall & Hilles, Yokohama, Japan, who has been in the East for several months, has left for San Francisco, from whence he will sail for Japan the last of this month. Mr. Hilles and his partner, Mr. Bagnall, have spent considerable time in the United States, looking up new apparatus, buying apparatus and supplies, several carloads of which have already been shipped to Japan. It is their intention, evidenced by the large purchases they have made, to light up the Orient more profusely than ever, and in the near future readers of The Electrical World may expect some very interesting notes of the progress of electrical matters in Japan, the Philippine Islands, etc., where Messrs. Bagnall & Hilles are extensively engaged in business.

ENGLISH NOTES.

(From our Special Correspondent.)

London, August 9, 1893.

SHIPS' SIDELIGHTS.—A curious accident is reported with regard to a 200 candle-power Swan lamp acting as the green light on a ship's side. The bulb of the lamp itself was of green glass, and the heat from the reflector at the back of it being focused upon it, the glass used gradually melted and finally collapsed under the pressure of the atmosphere.

THE GOVERNMENT AND THE TELEPHONES.—From a remark of the Postmaster-General in the House of Commons last week it is made clear that the post-office does not mean to go back from the attitude originally adopted by it with regard to the use of the telephone trunk wires which will shortly come into the hands of the government, viz., that all telephone concerns should have an equal right to make use of these trunk wires, no special privilege being conferred upon the National Telephone Company, from which they have been purchased.

WATER-GAS ENGINES FOR ELECTRIC POWER SUPPLY.—A letter has recently appeared in the "Journal of Gas Lighting" from Mr. Denny Lane, in which he criticises the general use of producer gas for driving engines for electric lighting purposes. It may be remembered that Mr. Lane some time ago advocated the use of engines driven by town gas for public electric supply, the gas mains practically taking the place of high-pressure electric mains. Indeed, a system of this sort is about to be tried at Belfast, where a number of gas engine sub-stations will be built. Mr. Lane's objections are directed against the great prime cost which the use of Dowson and other producer gases involves, as, owing to the low thermal value of these gases, the engines, mains, pipes, and storage tanks must all be very much larger for the same amount of power than where town gas is used.

MUNICIPAL ELECTRIC LIGHTING.—Some figures with regard to the capital expenditure which were given by Mr. Robert Hammond in a lecture delivered by him before the Association of Municipal Engineers at West Bromwich show in a remarkably striking way the tremendous development of municipal electric lighting in this country, a development which has as yet no counterpart in any other country of the world. At the present moment £4,500,000 is invested in central station enterprise by limited liability companies, and only about one-tenth of this sum by town councils. If, however, we turn to the money which is being spent on stations now in the course of construction, the position is altogether reversed. Limited liability companies are spending less than £100,000; municipalities almost £800,000. The allocation of the money which it is proposed to spend is still more significant. Municipalities have either decided to spend or are taking of spending a sum amounting to over £800,000, whilst this figure is £25,000 in the case of limited liability companies.

MUNICIPAL TELEPHONY.—The Glasgow Town Council has decided by 27 to 21 votes to adopt the recommendation of its telephone committee and to apply to the Postmaster-General for a telephone license. Before the report was adopted, a very instructive debate took place; and one opponent of the scheme characterized it as "rash and Quixotic," and the data upon which the recommendation was based as "crude and problematical." To this the advocates of the scheme replied that the mere application for a license in no way committed the Town Council, but that the possession of a license would be a remakably handy weapon in the hands of the Town Council in its endeavors to secure a repeal of the telephone protection clause that the National Telephone Company succeeded some little time ago in getting inserted in a municipal tramway bill. This argument makes it apparent that the proposed application for a telephone license is intended to free the town tramways from the intolerable incubus of protecting the telephones, should it be decided to adopt electric traction, rather than to secure its ostensible object: a cheap and efficient telephone service.

News of the Week.

ELECTRIC LIGHT AND POWER.

DAVENPORT, IA.—The People's Gas Light & Construction Company is seeking franchises.

PUNTA GORDA, FLA.—An electric light plant will be put in. K. B. Harvey is interested.

FRANKLIN, KY.—The council is investigating the cost of putting in an electric light plant. M. S. Harris is mayor.

TRENTON, ILL.—The city will consider proposals for putting in a system of electric lights. A free franchise will be given.

WAUSAU, WIS.—The City Council will investigate the matter of erecting or purchasing an electric plant to be owned by the city.

LA CROSSE, WIS.—The Council will appoint a committee to investigate the plan of the city having its own electric lighting system.

BROOKLYN, N. Y.—The Charities Commissioners are now considering plans for fitting up the new electric lighting station at St. Johnland.

UTICA, N. Y.—There is a project under consideration to utilize the water power at Trenton Falls, N. Y., for the generation of electricity for Utica.

LITITZ, PA.—Henry Kaufmann contemplates putting in an electric lighting plant, and he will use the incandescent system if he can get support enough for merchants.

FREDONIA, N. Y.—There is said to be a possibility of utilizing Cassadaga lakes as power to generate electricity. If this is done it would furnish power to Dunkirk and Fredonia.

PORT TOWNSEND, WASH.—A franchise has been granted authorized the Townsend Gas and Electric Company to construct and operate an electric light and power plant. W. H. Merrick, city clerk.

BORDENTOWN, N. J.—John Wiley, of Moorestown, Burlington County, N. J., is in the city calling upon members of the Common Council relative to the privilege of erecting an electric lighting plant in the city.

WEST TROY, N. Y.—Sealed proposals will be received at this arsenal until Sept. 7, 1893, for an electric lighting and power plant, one 60 gross tons electric traveling crane, one 2-h. p. and one 5-h. p. electric motor. Specifications and all other information can be had on application to Maj. Isaac Arnold, Jr., Ordnance Department U. S. Army, Commanding Watervliet Arsenal.

THE ELECTRIC RAILWAY.

BRADFORD, PA.—Solicitor Berry appeared before Council with a petition for a franchise for the Bradford & Kendall Electric Railway.

BIRDSBORO, BERKS COUNTY, PA.—The Birdsboro Electrical Railway has been granted permission by councils to lay tracks there.

BELAIR, MD.—The incorporators of the Deer Creek Electric Railroad Company have opened books for stock subscriptions, and enough was subscribed for to effect an organization.

MODESTO, CAL.—The Board of Stanislaus County have granted a franchise for an electric railroad from Oakdale to the Toulumne County line, to J. W. Dunlap and J. W. Woodside.

WARREN, PA.—J. H. Donley, of Warren, is now busy securing right of way for his proposed electric road between Franklin and Oil City. The capital will be $200,000 and construction will begin at once.

BALTIMORE, MD.—It is reported that the contract for the construction of the Baltimore & Drum Point Railway will be awarded to J. H. McCreery, of Washington, D. C., work to commence at once.

MIDDLETOWN, MD.—Assurance is given by parties in authority that the delay in commencing the proposed Frederick & Middletown Railroad is but temporary, and that the road will undoubtedly be built.

JAMAICA, L. I.—The matter of the street lighting contract went over by default, there being no quorum at the meeting. Three proposals were received. There is a strong feeling that the town should do its own electric lighting.

HARTFORD, CONN.—The Selectmen of Glastonbury have taken a favorable attitude in the matter of the franchise for the Hartford & Wethersfield Horse Railway, and President Goodrich, of the company, sates that work will soon be begun.

BAYONNE, N. J.—A franchise to substitute the trolley system for horses on the Jersey City & Bergen Railroad, in Bayonne, has been granted by the City Council, but the Council has refused the application of the Bayonne City Rapid Transit Company in its present form.

PERSONAL NOTES.

MR. A. HIGMAN, of the Inland Revenue Department, Ottawa, Can., has been appointed a delegate to the electrical congress and will represent British North America.

MR. ALEXANDER SIEMENS, who is one of the five English delegates to the electrical congress, arrived in New York last week. Mr. Siemens has been in the United States before, but not in recent years

PROF. ADRIEN PALAZ, one of the Swiss delegates to the International Electrical Congress, arrived in New York last week on his way to the Congress. Dr. Palaz is consulting electrical engineer of the Cie. des Chemins de Fer du Jura-Simplon, and is engaged on a project to build an electrical rack and pinion road over the Alps.

M. RENE THURY, of Geneva, Switzerland, will attend the International Electrical Congress as a delegate from Switzerland. It will be remembered that the international jury on the plans for the electrical utilization of the power of Niagara Falls awarded M. Thury the first prize for his plan, which was based upon the use of the continuous current.

MR. W. H. PREECE, one of the English delegates to the International Electrical Congress, arrived in New York last week and will leave the latter part of this week for Chicago. Mr. Preece is well known in electrical circles in the United States, not only for his valuable electrical work, but also on account of his connection with the electrical conference at Philadelphia in 1884.

MISCELLANEOUS NOTES.

ELECTRIC WELDING.—A Boston paper states the Thomson electrical welding machine now at work on the West End Railway Company makes about 800 welds a week with entire success. The work of the machine, it is stated, has generally been well done. In a few instances, where proper care was not taken to bring the ends of the rails closely together before welding, the concussion of a moving car has fractured the rail near the welded point, but this is only incidental, and is remedied by more care in the adjustments.

THE GENERAL ELECTRIC COMPANY.—The Chicago "Tribune" prints a sensational article on an alleged internal fight in the General Electric Company. It states that several weeks ago the directors of the General Electric Company held a meeting and that almost immediately thereafter the rumor became current that the friction between the Thomson-Houston and Edison people for the control of the company had developed considerable heat. It was reported that President Coffin had sold a large part of his holdings of General Electric stock and was gradually working out of the company. At the same time the report was spread that Eastern stockholders were dissatisfied at the workings of the General company, and that, in their opinion, the expense account as shown by the balance sheet was larger than conservative business principles would dictate. In this connection, E. H. Johnson, late president of the United Edison Company, is mentioned as likely to succeed Mr. Coffin in case of the latter's retirement from the presidency of the General Electric Company. Upon him, it is said, the Edison interests in the General company have united, and they will attempt to force his election as president.

Trade and Industrial Notes.

HARRY S. SMITH & CO., LIMITED, of Philadelphia, has taken into partnership Mr. Joseph W. Lucas, who has formerly been with the General Electric Company, at Schenectady, for the past four years.

THE FIRM OF YEARSLEY-SHINN ELECTRIC COMPANY, 123 North Third street, Philadelphia, Pa., was dissolved on Aug. 8, Wilson Shinn and J. F. Blymyer retiring. Mr. Yearsley will continue the business in his own name.

R. T. WHITE, 12 PEARL STREET, BOSTON, MASS., has issued a 48-page catalogue of material for street railway tracks, cable roads and car fenders, various forms of rails, chairs, switches and crossings are illustrated, as well as White's improved elevated railway system.

THE WOONSOCKET ELECTRIC MACHINE & POWER COMPANY has perfected the plans for its new building, and work of construction will soon begin. The building will be of brick and two stories high, to contain five stores and six offices and to be heated by electricity.

THE HAWKS ELECTRIC COMPANY, of Boston, has closed a contract with the village of Swanton, Vt., for a complete electric light system. This includes a Westinghouse 1,100-light dynamo and a 35-arc light dynamo of either Bell or Brush pattern. The contract calls for the completion of the plant Nov. 1.

ALEXANDER, BARNEY & CHAPIN, 18 Cortlandt street, New York, states that they are receiving orders for an unusual demand for electrical supplies of all kinds, both street railway and electric lighting. The A. B. C. Company is noted for supplying the trade with all that is new and first-class in the electrical line.

MR. J. GRANT HIGH, of 123 North Third street, Philadelphia, has recently received some very nice orders for switchboards of which he is now making a specialty. He is making these boards any desired size; this in addition to the single and double pole switch line is giving Mr. High a prosperous business, considering the general depression.

THE COMMERCIAL ELECTRIC COMPANY, Indianapolis, O., has recently arranged with the Diamond Incandescent Light Company, of Denver, Colo., and the Western Electric Supply Company, of Omaha, Neb., among others, to handle their machines. It has also secured an order for the machines to be used in lighting the Union Square Theatre, New York.

HINE & ROBERTSON, 57 Cortlandt street, New York, recently received an order for one of their straight line indicators from one of the largest electric light companies in the United States. On account of its low cost the company hardly expected it would fulfill the claims made for it. The trial, however, proved so satisfactory that this company at once ordered three more for use in its plant.

A. B. LAWRENCE, 225 Pearl street, New York, has secured an order for Schultz patent sable rawhide belting from the Watervliet Arsenal, West Troy, N. Y., calling for 4,000 feet with a gross value of $8,000, which followed an order for an 80-inch belt. Orders have also been received from the Thomson-Houston International Company for Talcahuano, Mexico, and from Guantanamo and St. Jago, Mexico, and Honolulu, Sandwich Islands, as well as for the complete equipment of Otis & Co.'s new factory.

THE DAHL ELECTRIC COMPANY, 120 Liberty street, New York, has recently placed a new alternating current motor on the market. This company, during the past few months, has brought out several types of motors and fan motors, which have met with special favor with the trade, and its success in this line has led the company to go farther, and the result has been a new motor.

HARRY S. SMITH & CO., LIMITED, Chestnut street, Philadelphia, is having a great demand for its new non-waterproof keyless receptacle, the parts of which are all exposed; they are made of porcelain, and especially adapted for use in damp or wet places where metal is liable to corrode; hence they are particularly applicable to ship use. This receptacle was designed by Mr. E. J. McEvoy, superintendent of electricity at William Cramp & Sons, ship builders, Philadelphia, and assembled by Harry S. Smith & Co., Limited. These receptacles are being used on all the ships built by this well known firm.

WARREN, WEBSTER & COMPANY have removed to their new factory and main offices in Camden, N. J. This is the only concern in the United States engaged in the manufacture of feed-water heaters, who build their output in its entirety in their own works, and are the patentees, owners and manufacturers of the Webster vacuum feed-water heater and purifier, builders and dealers in steam and power pumps, and the sole licensees of the sale of stationary right in the United States for the Willames vacuum system of steam heating. The house has branches in New York City, Boston and Chicago, and agencies in all manufacturing centres of this country, and frequent shipments of their productions are made abroad.

HELIOS ELECTRIC COMPANY, of Philadelphia, Pa., the well known arc lamp manufacturers, has recently received the following orders: World's Fair Columbian Exposition, 100 more lamps, making 600 in all; New York City, 50 additional lamps; Kennett Square, Pa., 25 lamps and 15 Spencer Economy coils; also several additional orders from various places amounting to 186 lamps. These orders are for immediate delivery. This company will double its working capacity this week. This large increase of business is ascribed to the present financial depression, for the reason that central station companies appreciate the fact that they can fulfill their full requirements at less expense with the Helios lamps than by installing a complete system of new dynamos and engines, new pole line and lamps.

THE BEACON VACUUM PUMP AND ELECTRICAL COMPANY, Boston, Mass., claims that its new lamp cannot be excelled for cheapness of manufacture, and with its unsurpassed qualities can scarcely fail to become a popular favorite. The inventors, as well as the Beacon company, are justly proud of the achievement, and believe that they have very nearly attained perfection in the development of an economical and efficient lamp of the modern incandescent type. They have signified their willingness to license other manufacturers to make their new and improved lamp, on a basis which will enable them to manufacture them, royalty added, at a less cost than they can make the lamps of other types, at the same time assuring manufacturers that their output would be greater in the same plant.

THE ELECTRIC APPLIANCE COMPANY of Chicago hard at work on its new catalogue, which will be a model of completeness, combined with compact form and arrangement. It is the intention to issue a very large edition, which will soon put into the hands of the Western trade the most desirable electrical supply catalogue that has ever been published. It will be undoubtedly awaited with considerable interest. The company reports that its business in electrical house goods does not seem to feel the depression that exists in other line of electrical trade, and is proving a valuable line to fall back on at a time when business in other departments is comparatively quiet. The Electric Appliance Company is building up a splendid trade in this line of goods, which has been comparatively neglected for the past few years in the interest of electric light supplies, and this company's electrical house goods have already established for themselves a reputation among the trade in this line.

THE PENNSYLVANIA ELECTRIC ENGINEERING COMPANY, of Philadelphia, has just completed the installation of the magnificent plant in the Commonwealth Hotel, Harrisburg, Pa. The proprietors of this hotel are very much elated, and express themselves as being entirely satisfied with the general construction of their plant. This plant consists of two large national multipolar generators; having a capacity of 2,000 lights, and driven by two Harrisburg ideal automatic engines. The dynamo room is elaborately finished in white enamel and decorated with gold, as is also the engine and dynamos. The switchboard is of white marble, highly polished, eight by ten feet. The outside of this hotel is lighted by eight Waterhouse arc lamps and run by the same generators, the lamp posts of which are very novel in design and construction and are being fed by underground service wires. It is completely equipped with Diehl ceiling fan motors and Crocker & Wheeler rotary fan motors. The Page Belting Company, of Concord, N. H., furnish the belting. The lamps used for lighting this hotel are the non-infringing Maggie Murphy lamp, which is the first exportation from their home. The Pennsylvania Electric Engineering Company was given a carte blanche order to furnish everything of the best quality consistent with its idear. Mr. J. Paul Gayord, president of this company, has just returned from Chicago, where he has been for the past two weeks looking at and studying the different electrical devices with a view to adopting the best in the construction of plants by his company. A representative of the company is now in Berlin, Germany, with the same object in view. This company does not bind itself to any particular system, but is always on the alert for any new device which may be an improvement in the construction of plants or electrical work in general.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.